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A pair of Planning Workshops to Develop Recommendations for a Ground Water Protection Strategy held June 22-27, 1980 in Reston, Virginia were set up to provide a small, knowledgeable group of representative State, local, environmental, business and industry, public interest and professional persons an opportunity to explore and analyze ground water issues and to recommend preferred policies. These technical appendices were compiled to accompany a study guide prepared for workshop participants, "Planning Workshops to Develop Recommendations for a Ground Water Protection Strategy" (NTIS Accession No.). Based on information currently available, these technical papers define the nature and extent of the ground water problem, identify the major policy choices, estimate related resources implications, and make recommendations for action in certain areas. Table of Contents:

Ground Water Fundamentals; Ground Water use in the United States; Summary of Ground Water Damage in the United States; Synthetic Organic Contamination in Ground Water; Analysis of State and Federal Program by Pollutant Source; Analysis of EPA Laws and Potential Application to Ground Water; A Synopis of Federal Laws Relating to Ground Water; Current State Ground Water Management Programs; Other Federal Programs with Ground Water-Related Responsibilities; and a Ground Water Research Strategy.

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Appendices

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DEVELOPING AN EPA
GROUND WATER STRATEGY

-- APPENDICES --

1A

DEVELOPING AN EPA
GROUND WATER STRATEGY

--Appendices--

These Appendices supplement the papers on "Developing an EPA Ground Water Protection Strategy" that were assembled for the Environmental Protection Agency workshops to be held in late June. They include papers on ground-water use and pollution, descriptions and analyses of current laws and activities at the Federal and State levels, and a discussion of research categories for ground water.

The ten papers serve various purposes and may appeal to readers of different professional interests and perspectives. The content ranges from a general overview of ground water (Appendix I) to technical discussions of various State and Federal laws affecting ground water (Appendices VI and VII) to possible future research in this area (Appendix X). Through this wide range of topics, these papers bring together current information on the subject of ground water.

This document will be made available to Workshop participants and others who wish further reading on the issues facing the EPA in developing a ground water protection strategy.

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ACKNOWLEDGEMENTS

This document represents the completion of Phase I of a three-phase approach to the development of a Ground Water Strategy. Phase I involved the assembling of current information on ground-water use and pollution, Federal and State laws and programs, and the state-of-the-art in ground-water protection. Phase II consists of the Planning workshops held in June and the publication of a strategy that reflects the views of the workshops in the Federal Register. Phase III will be five public meetings to be scheduled in the Fall.

This set of papers and appendices evolved from the working papers submitted by four EPA Work Groups composed of principal representatives of several Deputy Assistant Administrators and the Regions. Using information currently available, the Work Groups were asked to define the nature and extent of the ground-water problem, identify the major policy choices, estimate related resource implications, and make recommendations for action in selected areas.

A project of this proportion requires the collaborative efforts of many individuals working within various EPA programs and professional areas. The members of the Policy Committee and the Work Groups and their Task Force chairpersons are listed below. In addition, many persons from EPA Headquarters and Regional Offices participated as members. We thank them for their intensive work over several months that made this document possible.

Policy Committee

Victor Kimm, Deputy Assistant Administrator for Drinking Water (Chairperson)
Mike Conlon, Associate Deputy Assistant Administrator for Pesticide Programs
Swep Davis, Associate Assistant Administrator, Office of Water and Waste Management
Steven Schatzow, Deputy Assistant Administrator, Water Regulations and Standards
Roy Gamse, Deputy Assistant Administrator for Planning and Evaluation
Alan Hirsch, Deputy Assistant Administrator for Env. Processes and Effects Research
Henry Longest, Deputy Assistant Administrator for Water Program Operations
R. Sarah Compton, Deputy Assistant Administrator for Water Enforcement

Steffen Plehn, Deputy Assistant Administrator for Solid Waste
James Rogers, Associate General Counsel
Jack Schramm, Regional Administrator, Region III
David Standley, Director, Water Division, Region VIII
Charles Sutfin, Director, Water Division, Region V
Leonard Wood, Hydrologist, U.S. Geological Survey
Marian Mlay, Associate Deputy Assistant Administrator for Drinking Water, (Executive Secretary to Policy Committee)

Work Groups

Arnold Kuzmack, Director, Office of Program Development and Evaluation (Task Group Chairperson)
Alan Levin, Director, State Programs Division (Task Group Chairperson)
Merna Hurd, Director, Water Planning Division (Task Group Chairperson)
Jack Keeley, Chief, Ground Water Research Branch, Robert S. Kerr Environmental Research Lab (Task Group Chairperson)
Alan Abramson, Director, Water Division, Region VII
Ronald Brand, Acting Director, Program Evaluation Division
Hal Cahill, Director, Municipal Construction Division
Mark Gordon, Attorney, Office of General Counsel
Clint Hall, Associate Deputy Assistant Administrator for Env. Proc. and Effects Branch
Martin Halper, Director, Survey and Analysis Division
William Jordon, Chief, Industrial Permits Branch, Office of Enforcement
Albert Peter, Director, Land Disposal Division, Office of Solid Waste

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The document was compiled and edited by Marian Mlay, Nancy Wentworth and Pat Scholten.

APPENDIX I

GROUND WATER
FUNDAMENTALS

GROUND WATER FUNDAMENTALS

The nature and extent of the ground-water problem will be best comprehended with a basic understanding of the natural occurrence of ground water. This paper provides basic geology and hydrology information to workshop participants who do not have a technical background. While many experts attending the workshop will find this elementary, we hope it will be useful to participants who feel the need for a "refresher."

Ground water is defined as water that exists beneath the surface of the ground and occurs in aquifers which are geologic formations that contain enough saturated, permeable material to yield usable amounts of water to wells and springs.

Aquifers underlie most of the United States, although some of these aquifers are not widely used because of their depth, the quality of the water, or the yield of the aquifer. In general, the degree to which an aquifer is used is a function of the availability of good quality surface water and the relative cost of delivering the ground water to individual users.

Aquifers are categorized as unconfined (water table) and confined (artesian). Water table aquifers are overlain by material which is reasonably permeable so that water can percolate from the surface through the natural pore spaces or through open fractures. The upper surface of the saturated zone in the aquifer will be at atmospheric pressure and is referred to as the water table. In most cases, water table aquifers are fairly shallow and are interconnected to local rivers and creeks which will either receive water from the aquifer, recharge the aquifer or both.

Artesian aquifers are confined by a layer or layers of material such as clay or shale which are relatively impermeable so that water in a well tapping the aquifer will rise above the top of the aquifer. The amount of water level rise depends on the hydrostatic pressure at that point.

The recharge of confined aquifers has historically been considered to be in the upgradient portion of the aquifer where the confining beds are absent, allowing precipitation or infiltration from streams to directly enter the aquifer. In these zones the aquifer is under water table conditions. An example of this recharge zone would be found for the Atlantic Coastal Plain confined aquifers along with the western edge of the coastal plain near the Piedmont Province (the Fall Line). The amount of recharge would be controlled by the thickness of the unit, its areal expanse, surface conditions and the permeability of the unit, and amount of water available for recharge. A significant amount of recharge to confined aquifers occurs through the confining beds. Even though the confining beds are considered "impermeable," their low permeability still transmits considerable volumes of water over large areas. The term "aquiclude," referring to "impermeable" confining beds, is being replaced in hydrogeologic thought by "aquitard," referring to beds which retard the flow of water. The replacement of aquiclude by aquitard has occurred as a result of the recognition that confining beds do actually transmit large quantities of water over large areas.

The component material and structure of aquifers allows their further classification of aquifer into unconsolidated or consolidated rock, and primary or secondary permeability. Unconsolidated rocks such as alluvial and glacial sands and gravels consist of loose particles which transmit water through primary permeability. Primary permeability is due to open, interconnected pores occurring between particle grains which are created when the rock is formed. Consolidated sedimentary, igneous and metamorphic rocks are characterized by interlocking or cemented grains or minerals which make up the rock.

Consolidated rock may have both primary and secondary permeability. Secondary permeability is due to voids created in the rock sometime after its formation and solidification or consolidation. The secondary permeability features are joints, fractures, faults and solution channels. In consolidated rocks, the primary permeability is generally insignificant and the aquifer transmits water through the secondary permeability of fractures or solution channels. The exception generally is sandstone where, depending on degree of cementation, the primary permeability may be significant.

The unconsolidated aquifers (i.e., sand and gravel) are generally the most prolific ground-water producers because of their relatively high porosity and permeability. Consolidated rocks are variable in yield depending on degree of cementation or fracturing. Limestone and dolostone (carbonate rocks) yields are dependent upon the degree of fracturing and the enlargement of these fractures by solution of the carbonate mineral by acidic ground water. The igneous and metamorphic rocks are also dependent on fractures for permeability, except basalt. Whereas granite (the major igneous rock) and schist and gneiss (metamorphic rocks) owe their permeability entirely to fractures, basalt also may contain considerable primary permeability from lava tubes (open tunnels formed by entrapped gasses in the molten lava) and interbedded alluvial and weathered material which provides considerable yields in the basalt flows of the Columbia plateau of the Northwest.

The importance of aquifer types to ground-water contamination is that the relative ease with which contaminants migrate into the ground water is controlled by the permeability and component material of the aquifer and overlying earth material.

Confined aquifers are relatively safe from contamination by surface sources as compared to unconfined, water table aquifers. Confining beds (aquitards) tend to slow and inhibit the movement of contaminants and the upward-directed hydrostatic pressure in many confined aquifers prohibits flow into the confined aquifer. If overpumping of the confined aquifer is allowed, it may lower the hydrostatic head enough to allow movement of overlying contaminants into the confined aquifer. The historic conception that recharge occurs only in the up dip outcrops (as mentioned previously) leads to an erroneous conclusion that confined aquifers are completely immune from contamination outside of that outcrop area -- they are not completely immune.

Unconfined aquifers may be very vulnerable to contamination depending on the component material and thickness of the overlying unsaturated zone. Aquifers already designated as Sole Source Aquifers pursuant to Section 1424e of the SDWA such as the Edwards Limestone in Texas and the Spokane-Rathdrum Aquifer (alluvial sands and gravels) in western Washington illustrate the dangerous vulnerability of shallow aquifers which have little or no overlying earth material.

Unconsolidated aquifers consisting of sands or finer grained material act to slow down the advance of contaminant plumes in the aquifer. These finer grained materials along with clays and organic material in the unsaturated zone and in the aquifer provide attenuative capacity by sorption, ion exchange and filtration, all of which act to reduce concentrations of contaminants. This attenuative capacity is highly variable because of the interactions between different waste components and the earth material. Some contaminants are not attenuated at all, while others are attenuated under certain Eh/pH conditions, but not under other conditions.

Aquifers having secondary permeability transmit water through fractures or solution channels. Once contaminated, the plume may move very quickly, as in cavernous limestone with velocities of miles per day. In addition, consolidated aquifers having secondary permeability have much reduced capacities for attenuation.

Monitoring for ground-water contamination is dependent to a large degree type of aquifer. Aquifers of fractured or solution channeled rock have unpredictable flow paths which may change directions drastically as the ground water flows through the interconnecting fractures and channels. Unconsolidated alluvial and glacial deposits frequently consist of interbedded and interfingering lenses of clay, silt, sand and gravel. Flow paths through such complex geology are very difficult to deduce with the limited data generally available. Attempting to monitor ground water with wells in such conditions is often difficult and expensive, requiring considerable expertise in hydrogeology.

APPENDIX II

GROUND WATER USE
IN THE UNITED STATES

GROUND WATER USE IN THE UNITED STATES

This paper presents information on ground-water use and overdraft in the United States for the past, present and future as background to the development of a national ground-water protection strategy. It includes a presentation of a range of ground-water withdrawal projections for the years 1985 through 2000. Projecting the use of any product or service far into the future is difficult because the factors that affect its demand or use also change over time -- this is particularly the case with ground water. This paper will address the specific factors that affect demand and the magnitude of these factors over time.

There are several methods available for making projections. Some are as simple as applying the compound growth rate of past years to future years. Others involve the construction of complex mathematical models using techniques such as regression and correlation analysis. Additional methods involve the application of major indicators of change in a subjective manner to the forecasts. The latter approach is appropriate when major policy shifts in the future are expected to affect the underlying variables.

When using those techniques, care must be taken in determining the key independent variables and the sensitivity of the final forecasted results to changes in the values of the independent variables. If the sensitivity of the final forecasted results to the independent variables is not recognized and pointed out, the end user of the projections may be misled in conclusions reached using the projections. Such misuse of projections, particularly at the policy-making level, can lead to suboptimal decisions and misallocation of national resources.

The methods applied to the process of projecting ground-water use in 1985 and 2000 combine some elements from each of the above methods. Extrapolations of past trends, based on the Water Resources Council's (WRC) First National Water Assessment, are used for high range projections while historical ground-water use rates are applied to total national withdrawal projections published by the Water Resources Council in the Second National Water Assessment to generate medium range projections.

A lower range was projected to account for a number of causative factors such as energy costs which will influence future ground-water use. Each of these projections and the principle variables that may determine the future use levels are discussed in detail below. No mathematical models are presented in this document but the key variables are described. It is important to recognize the relationships between these variables which could be expressed mathematically.

The Past

The ground-water resource has become increasingly valuable during the past 35 years. An indicator of economic value is the withdrawal rate. Ground-water withdrawals in the United States have quadrupled since 1945, increasing from 21 billion gallons per day to 82 billion gallons per day in 1975. Withdrawals increased from 68 to 82 billion gallons per day during the five year period from 1970 to 1975. In 1975, total withdrawals from both surface and ground were approximately 340 billion gallons per day.

The largest share of the increase was attributable to withdrawals for agricultural purposes. Agricultural withdrawals were applied primarily to the irrigation of cropland. Irrigation withdrawal amounted to 21 billion gallons per day in 1950. By 1975, the rate was 57 billion gallons per day, an increase of more than 170 percent. That year, nearly 70 percent of the Nation's ground-water use was for agricultural irrigation. Other uses of ground water were also significant between 1950 and 1975. These include public water supplies, rural water supplies and industry.

The following table presents total fresh water withdrawals of ground water between 1950 and 1975 and a percentage breakdown by category of use.

TABLE I

HISTORICAL TRENDS IN GROUND WATER USES AS A PERCENT OF WITHDRAWALS: 1950-1975

	1950	1960	1970	1975
Total Fresh Ground-Water Withdrawals (bgd)	34	50	68	82
Public Supplies (%)	12	13	14	13
Rural Supplies (%)	8	6	5	5
Irrigation (%)	62	68	66	69
Industry (%)	18	13	15	14

Note: May not total 100% due to rounding.

Source: Murray and Reeves (1972, 1977) and MacKichen and Krammer (1961) based on USGS data.

THE PRESENT

At the present time, a number of factors are affecting the amount of ground water used. Agricultural irrigation, energy prices, manufacturing and mineral development, and ground-water overdraft are but a few of the influences on the demand for this resource. Ground-water withdrawal and overdraft vary regionally. This variation is reflected in Table 2 from the Second National Water Assessment by the WRC. The Tennessee Region has withdrawals of 271 million gallons per day while the California Region reaches 19,160 million gallons per day. A number of the regions have no overdrafting while in others overdrafts exceed 50 percent of total withdrawals.

TABLE 2

GROUND WATER WITHDRAWALS AND PERCENTAGE OF OVERDRAFT -- "1975"

Water resources region and No.	Total withdrawal (mgd)	Overdraft		Subregions		
		Total (mgd)	Percent	Number in region	Number with overdraft	Range in overdraft (percent)
New England (1)	635	0	0	6	0	---
Mid-Atlantic (2)	2,661	32	1.2	6	3	1- 9
South Atlantic-Gulf (3)	5,449	339	6.2	9	8	2-13
Great Lakes (4)	1,215	27	2.2	8	1	30
Ohio (5)	1,843	0	0	7	0	---
Tennessee (6)	271	0	0	2	0	---
Upper Mississippi (7)	2,366	0	0	5	0	---
Lower Mississippi (8)	4,838	412	8.5	3	3	7-13
Souris-Red-Rainy (9)	86	0	0	1	0	---
Missouri (10)	10,407	2,557	24.6	11	10	4-36
Arkansas-White-Red (11)	8,846	5,457	61.7	7	7	2-76
Texas-Gulf (12)	7,222	5,578	77.2	5	5	24-95
Rio Grande (13)	2,335	657	28.1	5	4	22-43
Upper Colorado (14)	126	0	0	3	0	---
Lower Colorado (15)	5,008	2,415	48.2	3	3	7-53
Great Basin (16)	1,424	591	41.5	4	4	7-75
Pacific Northwest (17)	7,348	627	8.5	7	6	4-45
California (18)	19,160	2,197	11.5	7	5	7-31
Regions 1-18	81,240	20,889	25.7	99	59	1-95
Alaska (19)	44	0	0	1	0	---
Hawaii (20)	790	0	0	4	0	---
Caribbean (21)	254	13	5.1	2	1	5
Regions 1-21	82,328	20,902	25.4	106	60	1-95

Source: U.S. Water Resources Council. Second National Water Assessment. Volume 1: Summary. December 1978.

For the category of largest use, agricultural irrigation, a few statistics are applicable to the development of projections for future demand. First, approximately 58 million acres, or about 14 percent of the cropland in the United States, are irrigated. The value of crops produced on irrigated land is estimated to be 25 percent of the total value of the Nation's crops. Ninety percent of the irrigated land is located in the 17 States farthest west (excluding Alaska and Hawaii). Approximately 47 percent of the fresh water withdrawn from ground or surface sources is used for irrigation. About 81 percent of consumption, i.e., water withdrawn from and not returned to ground or surface sources, occurs from irrigation.

The value of irrigation to the farmer is higher per acre for fruits and vegetables than for most field crops. Fruits and vegetables have high investment and production costs per acre. This increases the economic risk if the crops fail or yields are reduced because of drought. Irrigation reduces the risk of inadequate rainfall, allowing farmers to produce a plentiful supply of a high quality product at lower cost.

The total economic or social value of irrigation is more than just the increase in agricultural production. Additional economic growth is also generated in the agricultural processing and marketing industries. As production increases, the demand for fertilizer, machinery, pesticides, labor, and other commodities increases. This generates economic growth which is estimated to be approximately equal to the increase in the value of agricultural production.

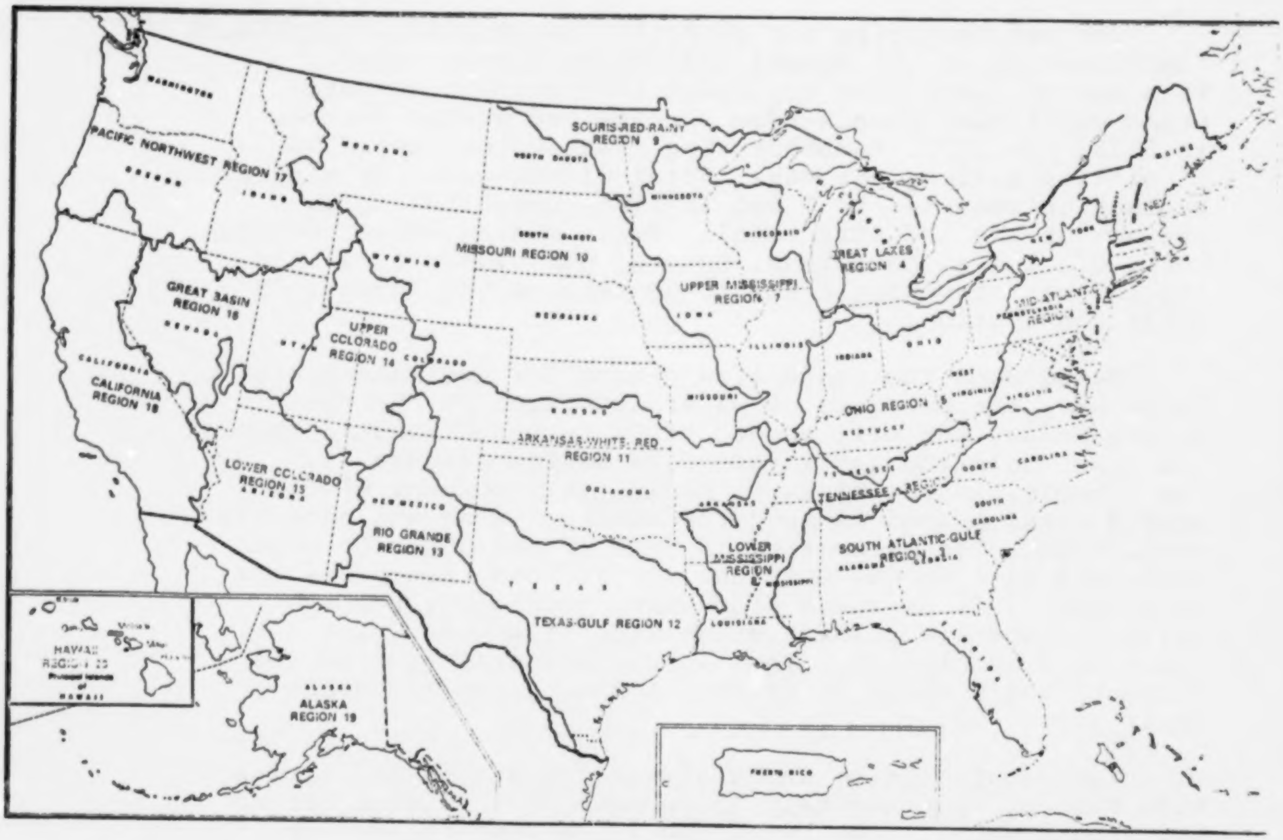
The manufacturing and minerals industry also contribute significantly to the demand and use of ground water. This set of industries represent 17.2 percent of total fresh-water withdrawals from surface and ground sources in 1975. In 1975, manufacturing fresh-water demand was 51 billion gallons per day. Total withdrawals for mineral production amounted to 7 bgd in 1975, constituting 36 percent of the industry total. Fuels mining which includes coal, oil shale, petroleum, natural gas, and natural gas liquids was responsible for 62 percent of the industry's total consumption.

Based upon the increasing demand for fuel and hence water use, the problems of water shortages in the fuels mining industries will appear first in the Missouri, Ohio and upper Colorado water resources basins (Figure 1). For example, in the Missouri Basin, 84.5 percent of all ground water pumped is used for manufacturing and minerals production. The percentage is 34.8 in the Upper Colorado Basin and 12.6 in the Ohio Basin. As these resources are developed, and, assuming production technology remains basically the same, the availability of ground water could be a constraint. This is particularly true in the Missouri Basin where 10 of the 11 subregions overdraft their ground water.

The manufacturing and minerals industries and irrigation make up approximately 83 percent of the total demand for ground water. The remaining 17 percent is used by public and rural water supplies. In 1975, 21 billion gallons per day (bgd) were withdrawn for use by central municipal systems which was 13 percent of the total demand for ground water. Rural noncentral systems used 2 bgd or 5 percent of the total demand.

FIGURE 1

WATER RESOURCES REGIONS


WASHINGTON
PACIFIC NORTHWEST REGION 17
OREGON
IDAHO
MONTANA
SOURIS-RED-RAINY REGION 9
NORTH DAKOTA
MINNESOTA
WISCONSIN
SOUTH DAKOTA
MISSOURI REGION 10
WYOMING
GREAT LAKES REGION 4
UPPER MISSISSIPPI REGION 7
IOWA
GREAT BASIN REGION 16
NEVADA
UTAH
UPPER COLORADO REGION 14
COLORADO
NEBRASKA
ILLINOIS
INDIANA
OHIO
MID-ATLANTIC REGION 2
PENNSYLVANIA
CALIFORNIA
CALIFORNIA REGION 18
MISSOURI
KANSAS
WEST VIRGINIA
VIRGINIA
OHIO REGION 5
KENTUCKY
ARKANSAS-WHITE-RED REGION 11
LOWER COLORADO REGION 15
ARIZONA
OKLAHOMA
NORTH CAROLINA
TENNESSEE REGION 6
NEW MEXICO
ARKANSAS
SOUTH CAROLINA
RIO GRANDE REGION 13
LOWER MISSISSIPPI REGION 8
SOUTH ATLANTIC-GULF REGION 3
ALABAMA
GEORGIA
MISSISSIPPI
TEXAS
TEXAS-GULF REGION 12
LOUISIANA
MAINE
NEW YORK
HAWAII REGION 20
Principal Islands of HAWAII
ALASKA
ALASKA REGION 19
PUERTO RICO

Source: U. S. Water Resources Council. Second National Water Assessment. Volume 1: Summary. December 1978

THE FUTURE

The factors that affect the past and present will continue to be predominant consideration for ground water demand in the future. The two key variables which account for over 80 percent of the ground-water demand on a national basis are agricultural irrigation and manufacturing and minerals development. Ground-water use for public domestic supplies is a particular concern in quality terms but comparatively small in quantity terms.

The demand for ground water as a source for domestic use and manufacturing and minerals development is likely to continue to be relatively stable as a percentage of the total demand. This is particularly true for minerals development and domestic uses. Manufacturing demand for ground water will probably continue to decline through 1985 as the Clean Water Act's pollution abatement program increasingly affects water uses by manufacturing. Recycling and reuse is being introduced not only for manufacturing, but also for the recharge of aquifers.

There are several parameters that will affect the demand for ground water as a source of irrigation water, the largest of the uses. The first of these is overdrafting -- the withdrawal of water on a long-term basis at a rate which is greater than the aquifer's recharge. Approximately 25 percent of all ground-water withdrawals nationally were overdrafts in 1975 and much of the water was applied to agricultural irrigation.

A second factor that continues to have an influence on irrigation is the cost of energy for pumping. With overdrafting situations, supply wells have to be drilled deeper (or abandoned), thus increasing the amount of energy used for pumping. An associated concern is that energy prices are rising faster than prices for other productions. If the energy prices faced by farmers increase by a factor of 5 or 10 from their relatively low 1970 levels, pumpage for agriculture could become uneconomical for many low value or water intensive crops or locations of cropland. Energy prices for pumping increased fourfold between 1970 and 1980.

The projections of ground-water use are reflected in Table 3 and Figure 2.

TABLE 3

PROJECTED GROUND WATER WITHDRAWALS FOR THE YEARS 1985 and 2000

(Billion Gallons Per Day)

	High[1]	Medium[2]	Low[3]
1970		68	
1980	82		86
1985		69	77
1990	95		70
2000	100	90	73

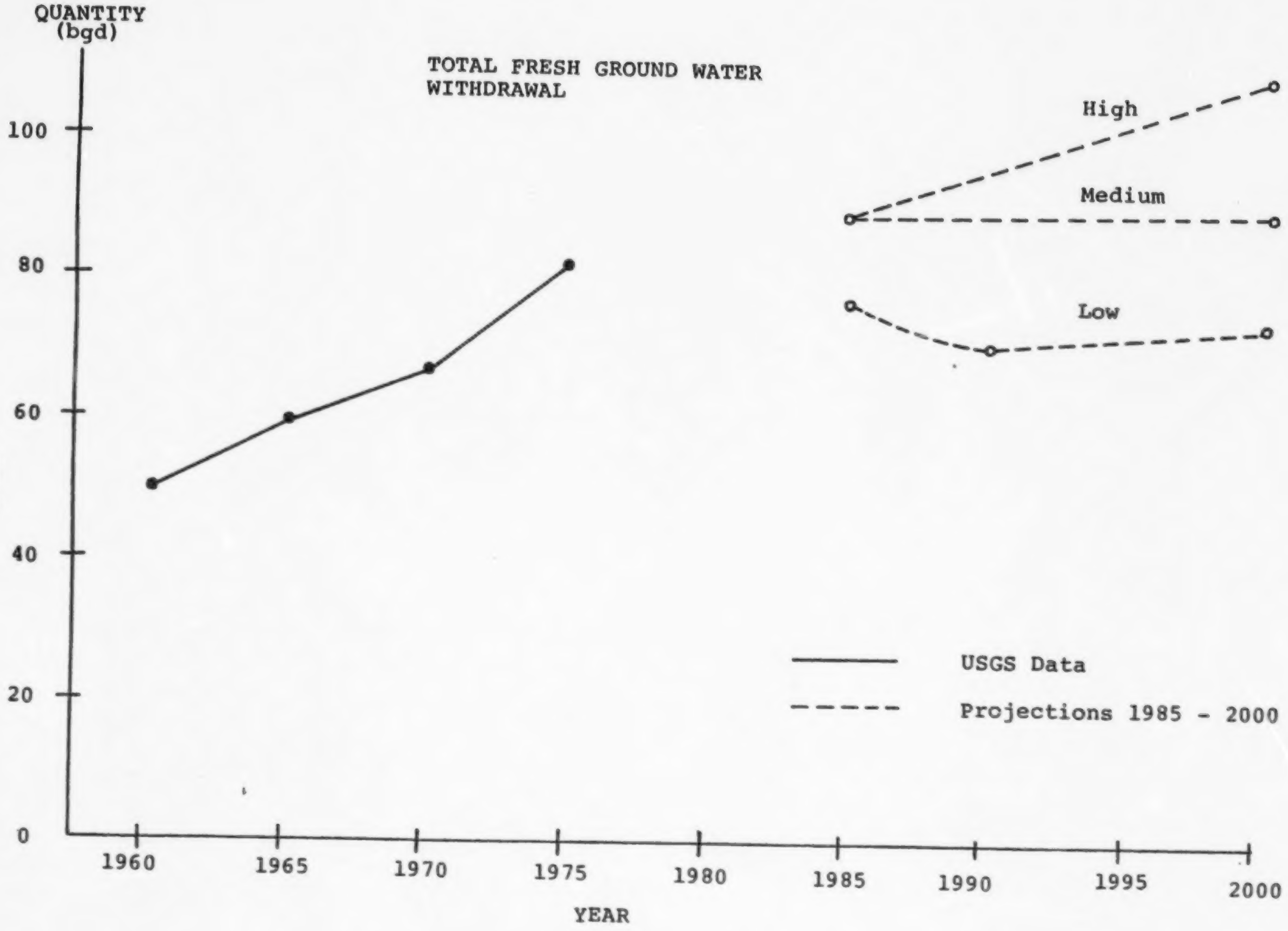
---

[1] U. S. EPA Report to Congress. Waste Disposal Practices and Their Effects on Ground Water, January 1977.

[2] INTASA, March 1980. Ground Water Use and Overdraft in the United States. Prepared for U.S. EPA. Based on WRC Second National Water Assessment and USGS Report Estimated Water Use in the United States in 1975 (Murray and Reeves).

[3] INTASA, Preliminary and approximate. Decreases attributable to increased energy costs, etc.

FIGURE 2



TOTAL FRESH GROUND WATER WITHDRAWAL

APPENDIX III

PRELIMINARY ANALYSIS OF THE EXTENT OF GROUND-WATER CONTAMINATION IN THE UNITED STATES

PRELIMINARY ANALYSIS OF THE EXTENT OF GROUND-WATER CONTAMINATION IN THE UNITED STATES

The development of a ground-water protection strategy requires an understanding of the significance of the ground-water contamination problem:

> How extensive is ground-water contamination at the present time?
>
> Is the amount of contamination increasing?
>
> To what extent can ground-water contamination be reduced once it occurs?

Numerous reports and studies have demonstrated convincingly that ground-water contamination is a widespread problem that affects every region of the country. For example, the EPA Region II office has reported that at 13 locations in New York during 197378, 28 public wells, serving two million people, and 380 private wells were contaminated. In eleven separate incidents in New Jersey during 197879, at least 115 wells were closed and one major aquifer was damaged. The existing reports and studies have been helpful in that they have:

> Documented a large number of contamination incidents,
>
> Identified the most important sources of contamination,
>
> Determined the mechanisms by which contamination occurs,
>
> Studied the contamination caused by some incidents in depth, and
>
> Surveyed the number of some types of potential sources of contamination in the nation.

However, none of these reports and studies have tried to assess the extent of the groundwater contamination problem in quantitative terms. In short, a large data base has been gathered, but no conclusions about the significance of the problem have been developed.

This report provides a preliminary assessment of the extent of the ground-water contamination problem at the present time. In doing so, it provides a base from which further evaluation of the extent of existing contamination and the magnitude of the potential future problem can be performed.

ASSESSING THE PROBLEM

There are two possible approaches which can be used to estimate the extent of the ground-water contamination problem. One approach is to sample and test the ground water at randomly selected locations and use the results to generate a national estimate of ground-water contamination. If a sufficiently large statistical sample is drawn, this approach can provide a good estimate of the extent and the nature of the contamination problem. The limitation of this approach from a strategy standpoint is that it does not provide much information on the cause of the contamination and implicitly on what needs to be done to control it. Although a complete survey of ground water would be useful, the time, cost, and technical demands of this approach preclude its use at this time.

An alternative method of assessing the ground-water contamination problem is to focus on the sources of contamination. Using estimates of the number of sources of contamination and the amount of contamination per source as its basic components, this approach can be used to develop an order of magnitude estimate of the size of the ground-water contamination problem. This second approach is less precise, but it can make use of the existing quantitative and qualitative information on ground-water contamination, and because it begins with an estimate of the number of sources, it provides a useful starting point for the development of a ground-water protection strategy.

The remainder of the report presents a preliminary assessment of the significance of the ground-water contamination problem using this second approach. Our analysis will proceed as follows:

Identify the sources of contamination.

Determine which sources are the most important from a national perspective.

Estimate the area of ground water contaminated by the most important sources of contamination:

- Estimate the number of contaminating sites in each source category;
- Estimate the area contaminated by each site;
- Calculate the total area contaminated in each source category;
- Aggregate the estimated contamination from all source categories.

Discuss the probable extent of contamination from sources that could not be quantitatively measured.

Compare the area contaminated to the total area of usable surface aquifers.

ANALYSIS OF THE EXTENT OF GROUND-WATER CONTAMINATION

Identification of the Causes of Contamination

A survey of the many reported incidents of contamination indicates that there are a wide variety of sources of contamination. Despite their differences, the sources can be divided into two subsets: waste disposal-related sources and non-disposal sources. These sources are:

Disposal Sources

Animal Feedlots
Industrial Impoundments
Industrial Landfills
Injection and Disposal Wells
Landspreading of Wastes
Mining
Municipal Wastewater Disposal
Petroleum Exploration
Subsurface Disposal Systems

Non-Disposal Sources

Accidental Spills
Buried Storage Tanks
Irrigation Return Flows
Natural Leaching
Salt Water Encroachment
Use of Fertilizer and Pesticides
Use of Road Deicing Chemicals

In recent years attention has centered on the potential contamination from land disposal of wastes because these wastes often contain a large amount of toxic materials, are primarily deposited in specific sites, and can be dealt with through specific regulatory controls. These sources of ground-water contamination should become relatively more important in the future as air and surface water pollution controls become more restrictive and waste generation increases.

Although non-disposal sources are perhaps responsible for a large portion of the current contamination problem, their impacts are not easily measured or projected and they are difficult to control through regulation. There appear to be three types of non-disposal contamination sources: (1) natural events, which cannot be prevented but whose effects can sometimes be reduced through proper management; (2) accidental events, which can be prevented by better individual transportation and storage practices; and (3) unwanted by-products of useful activities which can only be reduced through alteration of the manner in which the activities are carried out. Available reports and anecdotes indicate that the extent and impacts of contamination from non-disposal sources are highly area and incident specific. Therefore, because no estimates exist of the current extent of non-disposal contamination problems and the contamination cannot reasonably be estimated using simple modeling techniques, our preliminary analysis will concentrate on disposal-related sources of contamination.

Determination of the Importance of the Sources of Contamination

The diverse nature of the activities and contaminants causing groundwater pollution makes it difficult to rank the importance of different contamination sources. Among the factors that could be included in the ranking of sources are the number of potential outlets for contamination, the type of contaminants, the toxicity of the waste stream, the size of the area affected by a typical contamination incident, and the number of persons affected by a typical contamination incident.

There are two more simplistic approaches which can be used to determine which sources may be the most important. One approach is to examine the volume of wastes deposited on the land by different sources. A second approach is to review past reports of groundwater contamination to see which sources are mentioned most frequently. Although these approaches can only indicate the relative importance of the problem, they are used here for this preliminary assessment.

Table 1 presents estimates of the amount of waste deposited on the land through different disposal operations. The amounts are measured in both tons and gallons, but since both measures are available for industrial impoundments, the overall volumes can be compared. The tonnage figure for liquid wastes refers to the solid portion of the waste present. The volume estimates in the table suggest that industrial landfills and impoundments are the most important sources of ground-water contamination. Municipal landfill and wastewater sludges are substantial in volume, but generally much less toxic. Mining and petroleum exploration wastes are significant, but often are located in less populated areas.

A review of the existing reports on contamination incidents also provides insights about which sources are the most important:

> The study "Major Sources of Ground-Water Contamination in Connecticut" reported: Leachate from 25 out of 185 active landfills has degraded ground-water quality and leachate migration at the other 160 landfills is suspected. At least 100 of these sites are in public water supply watershed areas or are located on permeable soil.
>
> Leachate from 30 of 335 known industrial landfills or impoundments has caused documented ground-water contamination. There may be as many as 1,000 industrial waste disposal sites in the state. In the 30 reported cases, 53 private and municipal wells and six local ground-water supplies were contaminated. Subsurface disposal systems, the use of road salts, and accidental leaks and spill have caused numerous site-specific ground-water contamination problems.
>
> A Massachusetts government report on chemical contamination identified 22 communities affected by chemical contamination of their water supplies. In 11 of the cases, a total of 15 private wells and 16 municipal wells were contaminated. The report also discussed 22 other cases in which chemical contamination of ground water is suspected but has not yet affected drinking water

TABLE 1

ANNUAL WASTE DISPOSAL ON LAND IN 1977

Type of Waste and Site	Industrial/Commercial (million tons/year)		Waste Liquids (billion gallons/year)	
Solid Waste		375		
Industrial Landfill	240			
Municipal Landfill	135			
Semi-Solid Waste/Sludge		15		
Industrial Landfill	5			
Industrial Impoundment	5			
Municipal Landfill	5			
Liquid Waste		110		
Industrial Impoundment	110			1,700
Mining Sites				950
Septic Tanks and Cesspools				800
Municipal Waste Treatment				300
Petroleum Exploration				300
Impoundments			40	
Injection/Disposal Wells			260	
Total		500	4,050	
Total Hazardous (15%)		(55)		

Source: EPA reports and staff estimates.

supplies. The majority of the cases involved improper or illegal land disposal of industrial wastes or accidental leaks and spills.

In 1979, the Michigan Department of Natural Resources undertook an assessment of ground-water contamination problems in the state. They identified 260 sites where the ground water is known to be contaminated and 375 sites where the ground water is suspected to be contaminated. Of the 260 confirmed contamination cases, the majority involved accidental leaks and spills, 20 percent involved impoundments, and 15 percent involved landfills. In addition, Michigan officials estimate that 50,000 other sites in the state have the potential to cause ground-water contamination. An examination of the 781 cases in the Office of Solid Waste files revealed that 32 percent of the cases involved landfills or dumps, 12 percent involved surface surface impoundments, and 18 percent involved other disposal incidents. The remaining cases included spills and accidents at storage or manufacturing sites.

In 1966, the Texas Water Commission began an investigation of 23,000 cases of ground and surface water contamination caused by petroleum exploration. (1, p. 314)

These reports indicate that while there are regional variations in the importance of different contamination sources, a significant proportion of reported contamination problems are caused by the disposal of industrial wastes. These findings are consistent with the conclusions reached in the 1977 Report to Congress on Waste Disposal Practices and Their Effects on Ground Water.(1)

The 1977 Report identified the disposal of industrial wastes at industrial impoundment and solid waste disposal sites as the most important source of ground-water contamination. The majority of the current landfill and impoundment sites are unlined, but the extent of contamination is usually not recognized because operators do not monitor for ground-water contamination. Nevertheless, because these sites are often located in or near highly populated residential or industrial areas, ground-water problems have been discovered in many communities. In addition, the highly toxic nature

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(1) Referred to as the 1977 Report.

Of the contaminants further increases the importance of landfills and impoundments as sources of contamination. Consequently, this preliminary assessment of the extent of ground-water contamination will focus on landfills and impoundments.

The 1977 Report identified four other sources as having secondary importance nationally. The concentration of toxic materials and the total volumes of waste materials deposited on the land are lower for these sources than for industrial waste disposal operations. Nevertheless, these four sources, subsurface disposal systems, municipal wastewater, mining activity, and petroleum exploration, can have significant regional impacts in areas where they are highly concentrated.

Regional Distribution of Contamination Problems

Although landfills, impoundments, and the other important sources of ground-water contamination are found in all areas of the country, the type and size of the ground-water contamination problem in any region depends on the land use in that region. Although the purpose of this analysis is to estimate the total areal extent of ground-water contamination, the second phase of any assessment of contamination must examine how contamination problems are distributed around the nation.

Evaluations of the ground-water resource and case studies of the causes of contamination have been published for five areas. The remaining two regional assessments covering the Midwest and North Central states are not yet complete. A summary of the regional rankings of contamination problems by source is presented in Table 2. In the Northeast, Southeast, and Northwest, where there are areas with substantial manufacturing activity and high population densities, industrial waste and domestic sewage disposal have the largest impacts on ground water. In areas where petroleum exploration and mining activity are concentrated, those activities cause the most commonly reported contamination problems.

Regional differences in contamination problems are in part determined by regional weather differences. In very dry areas of the country, the South Central, Southwest, and parts of the Northwest region, irrigation return and natural

TABLE 2

RELATIVE IMPORTANCE OF DIFFERENT SOURCES OF GROUND-WATER CONTAMINATION

	National	Northeast	Southeast	South Central	Southwest	Northwest
Industrial impoundments	I	I	I	III	III	I
Land disposal sites	I	I	I	II	II	II
Septic tanks & cesspools	I	I	I	III	III	I
Municipal waste water	II	II	III	II	III	I
Petroleum exploration	II	III	III	I	I	I
Mining	II	II	II	II	III	II
Other important contamination sources, including non-disposal sources		Spills; leaks; road salt; storage tanks.	Spills, leaks; storage tanks; agricultural activities.	Natural leaching; irrigation return; abandoned wells.	Natural leaching; irrigation return; sea water encroachment.	Irrigation return; abandoned wells.

NOTE: Relative importance is based on the typical health hazard of the contaminants, the typical size of the area affected, and the distribution of the waste disposal practice across the U.S. A waste disposal practice may be a serious problem in certain areas, but if the number of such areas is relatively small, then the practice would not be given a high national rating. A very widespread practice which does not create serious problems even where sources of contamination are concentrated would also be given a low rating with regard to national importance. The ratings in the table are defined as follows:

I - high,
II - moderate,
III - low.

SOURCES: National significance: EPA, Report to Congress on Waste Disposal Activities and Their Effects on Groundwater, 1977, p. 8.

Regional significance derived from: Fuhrman, D. and J. Barton Groundwater Pollution in Arizona, California, Nevada and Utah, 1971, p. 87; Miller, D., F. Deluca and T. Tesser, Groundwater Contamination in the Northeast States, 1974, p. 150; Scalf, M.R., J.W. Keeley and C.J. LaFevers, Groundwater Pollution in the South Central States, 1973, p. 78; Vander Leeden, F., L. Cerrillo, and D. Miller, Groundwater Pollution Problems in the Northwest United States, 1975, p. 229; Miller, D., P. Hackenberry, and F. DeLuca Groundwater Pollution Problems in the Southeastern United States, 1977, p. 143.

leaching are substantial problems and land disposal of industrial wastes is not. In these areas, evaporation usually exceeds precipitation. Although this often prevents land disposed materials from achieving field capacity and creating leachate, it causes water drawn and used on the surface to have high concentrations of salts and solids. Thus, the ground-water problem in these areas is generally the increasing concentration of total dissolved solids. In the "wet" eastern regions of the U.S., landfill leaching is an important problem; accidents and the buildup of contaminants as a byproduct of useful activities create the additional significant contamination problems. Contamination problems in these regions are likely to be caused by the dumping of wastes and other materials on the land. The regional reports contain many anecdotal reports of ground-water contamination and should be consulted if more specific information on regional contamination problems is desired.

Evaluation of the Contamination Caused by the Important Sources

Although the national ranking of the impacts of waste disposal practices is a composite measure of contamination problems, it provides a workable structure for our estimate of the extent of groundwater contamination in the United States. For the two categories rated high in national importance, impoundments and landfills, specific estimates will be made of the areal extent of contamination. This analysis will be followed by an evaluation of the regional impacts of three of the sources ranked moderate in importance; subsurface disposal systems, petroleum exploration, and mining activity. The extent of the contamination caused by leaking sewer lines (municipal wastewater activities) is not evaluated due to limited time and information.

A simple model is used in this analysis. First, the number of sites that potentially could cause contamination is estimated. Characteristics that affect the contamination potential of sites include: permeability of the soil; existence of a surface aquifer beneath the site; type, concentration and amount of waste at the site; and site design and operating procedures. Second, the surface of the plume beneath the site is estimated. These estimates are rough and are related to judgments about the behavior of contaminants entering the ground water. Although the timing and mechanisms of contamination from landfills and lagoons are somewhat different, the analysis assumes the behavior of leakage from impoundment sites and leachate from landfill sites is the same once the contaminated stream enters the ground. Finally, the area of contamination per site is multiplied by the number of contaminating sites to get the total area of contamination per source.

Extent of Contamination from Industrial Impoundment

For the impoundment analysis, only active impoundments are considered; it is assumed that on inactive sites the liquid in the impoundment has drained away or evaporated and that the site has the contamination potential of an inactive landfill. The Surface Impoundment Assessment (SIA), funded by EPA and conducted by the states, has identified 25,000 active industrial impoundments at 11,000 locations across the U.S. An analysis of the results of the survey indicates that about two-thirds of the active impoundments are unlined and can be considered potential sources of contamination. The analysis also indicates that half of the impoundments are located over usable aquifers[1] and on highly permeable soil; ground water in these areas is highly susceptible to contamination. Using this information, it is estimated that approximately 8,400 industrial impoundments may leak into usable aquifers.[2]

The area of contamination caused by a leaking impoundment is determined by the amount and type of waste, the length of time leakage has taken place, and the geology and the hydrology of the area where the impoundment is located. EPA's analysis indicates that the typical industrial impoundment is about 10 acres in size and has operated for about 10 years. Assuming that the impoundment is located on permeable soil, the surface area contaminated would total about 60 acres. Thus, if 8,400 impoundments each produce a contaminated area of 60 acres and none of the plumes overlap or are intercepted by surface water, the total area of contamination caused by industrial impoundments would be 504,000 acres or 790 square miles. However, since the survey results indicate that many sites include several impoundments, the plumes may overlap and the total surface area contaminated may be lower. Consequently, for the preliminary assessment a range of 400 to 800 square miles for industrial potential impoundment contamination will be used.

1/ In this analysis, a usable aquifer is defined as a surfacial aquifer capable of yielding water containing not more than 1,000 ppm of dissolved solids.

2/ 25,000 x .67 x .5 = 8,400 impoundment.

Extent of Contamination from Landfills

An estimate of the contamination from land disposal sites other than impoundments is more difficult to make than was the estimate for impoundments. First, there is no inventory of active landfills comparable to the SIA. Second, because landfills maintain the capacity to leach for extended lengths of time, both active and inactive sites must be considered. Third, since landfills generally contain solid or semi-solid waste, leaching depends on rainfall and may be intermittent. Fourth, no ones knows how much waste has been illegally dumped at unauthorized locations through the years.

Finally, although only a portion of the waste stream disposed of on land contains hazardous materials, hazardous and non-hazardous wastes are not always disposed of separately. All these factors must be taken into account in the estimate of the number of contaminating land disposal sites.

The total number of active landfills has not been rigorously surveyed; a 1977 Waste Age survey identified 15,000 municipal landfills, and Fred C. Hart Associates has estimated that there are 75,700 industrial landfills.[1/] Fred C. Hart Associates has also estimated the number of active and inactive (now closed) sites which must exist in the nation to have handled the amount of hazardous industrial waste which has been generated in the U.S. They estimate that there must be 19,400 active sites and 31,300 inactive sites for a total of 50,700 sites.[2/] Since there are 10,400 active landfills, this would leave 40,300 active and inactive landfills. According to these calculations, the total number of sites is 2.6 times the number of active sites. Since the disposal of hazardous waste is not separate from the disposal of non-hazardous waste, however, the number of sites where hazardous waste is located is certain to be higher.

1/ Discussion of both estimates can be found in U.S. EPA, Environmental Impact Statement: Criteria for the Classification of Solid Waste Disposal Facilities and Practices, Appendices D and G, December 1979. For Derivation of the estimated number of industrial landfills, see Fred C. Hart Associates, Analysis of the Technology, Prevalence, and Economics of Landfill Disposal of Solid Waste in the United States, February 19, 1979, p. 48.

2/ Fred C. Hart Associates, Preliminary Assessment of Clean-Up Costs for National Hazardous Waste Problems, 1979, p. 22.

An estimate of the total active hazardous and non-hazardous industrial and municipal waste sites is 101,000 sites.[1] An estimate of total active and inactive sites would be 2.6 times this number, or 263,000 sites, of which 253,000 are landfill sites. Consequently, the number of landfill sites where there is hazardous waste is 40,000-253,000 sites.[2]

Of these 40,000-253,000 sites, however, not all will leach into usable aquifers. Assuming that industrial impoundments and landfills accepting industrial (i.e., hazardous) waste are generally sited in the same geographic area, then, like impoundments, about 50 percent of the landfills are located on permeable soils over usable aquifers. Unlike surface impoundments, the absence of a lining at landfills cannot be used alone to predict the probability of leakage. Although most landfills are unlined, only about 71 percent are located in areas having sufficient rainfall to cause leaching.[3] This analysis indicates that, at the present time, 14,000 to 90,000 land disposal sites are currently contaminating surface aquifers.[4]

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[1] 75,700 industrial landfills, 15,000 municipal landfills, and 10,400 surface impoundments.

[2] The upper end of this range (253,000) may greatly exceed the number of sites where hazardous waste has been deposited. The Chemical and Allied Products Industry generates about one-fifth of the total industrial wastewater and one-fourth of the total industrial solid waste produced in the U.S. The Eckhardt subcommittee report on disposal practices by the 53 largest chemical company identified 3,363 sites used by the companies since 1950 to dispose of hazardous and non-hazardous waste; sixteen percent of the sites were municipal sites, 31 percent were company-owned facilities, and a larger number appear to be improper disposal sites.

[3] EPA, 1977 Report to Congress on Waste Disposal Activities and Their Effect on Groundwater, p. 152.

[4] For simplicity, this analysis will not discuss the implications of the seasonal variations in rainfall and leaching.

40,000 x .5 x .71 = 41,200 landfills
253,000 x .5 x .71 = 89,815 landfills

Test results confirm that a high proportion of landfills do contaminate ground water. A 1977 study, "The Prevalence of Subsurface Migration of Hazardous Chemical Substances of Selected Industrial Waste Land Disposal Sites," presented the results of ground-water testing at 50 disposal sites. Of the 50 sites, thirtyfour were landfills, eight were surface impoundments, and eight were a combination of the two. Although none of the fifty sites had previously reported any contamination problem, organic contaminants were detected in the ground water at 40 sites and the migration of one or more hazardous substances was confirmed at 43 sites. At 26 sites, hazardous inorganic constituents in the ground water exceeded EPA drinking water standards.

In the absence of better estimates, we assume in this preliminary analysis that a landfill leaching into a surface aquifer has a contaminant plume that is the same size as an impoundmentrelated plume (60 acres). Therefore, the total area of contamination produced by 14,000 to 90,000 active and inactive landfills would be 1,300 to 8,400 square miles.

If none of the plumes overlap or intersect surface water, the total area of contamination from industrial impoundments and landfills would be 1,700 to 9,200 square miles. Since the total area of United States is 3.5 million square miles, of which 60 percent is underlain with usable aquifers, about 0.1-0.4 percent of the country's usable (surface) aquifer area is contaminated with toxic materials from industrial impoundments and landfill sites.

Although the estimated contaminated area may seem relatively small in comparison to the total area, two other aspects must be considered. First, the impoundment and landfills are generally located in areas of significant domestic and industrial water use. Therefore, depending on the demand for ground water, the area contaminated could be a substantial portion of the area where ground water is heavily used. Moreover, significant withdrawals of ground water will pull a nearby plume toward the point of withdrawal, so that the area whose ground water is no longer usable will be larger than the plumes themselves. Second, landfills and impoundments are only two of the many sources of contamination. A discussion of three other sources of contamination, all of which have the potential to contaminate large areas, follows in the next section.

Evaluation of Secondary Sources of Ground-Water Contamination

Three activities that can affect large regions are the use of subsurface disposal systems, petroleum exploration, and mining. The ground-water contamination problems associated with each activity are well-documented; but no quantification of the extent of contamination caused by these sources is available. Unfortunately, the simple modeling approach used to estimate the contamination caused by landfills and impoundments cannot be used to estimate the contamination caused by subsurface disposal systems, petroleum exploration and mining activities. Because many of the contaminants involved (e.g., salt, nitrates) are a problem only when highly concentrated in the ground water, the extent of contamination is a function of the density of the sites rather than just the number of sites and the leachate from each kind of site. Petroleum exploration and mining activity can cause contamination in several unrelated ways; a variety of types of contamination sources, ranging from pits and slag piles to general operations such as drilling or digging, can be found at any one site. Although a precise quantification of the total contamination caused by each of these three sources is not attempted here, a rough estimate of the magnitude of the contamination caused by these sources is presented.

Contamination from Subsurface Disposal Systems

Regional ground-water quality problems have been identified and documented in these communities having high densities of subsurface disposal systems. Ground water in these regions, primarily located in Southern California and on the East Coast between Boston and Washington, D. C., has been degraded by high concentrations of nitrates, bacteria, and other contaminants. The problem is magnified by the fact that in many areas, especially rural communities, a substantial reliance on subsurface disposal systems is paralleled by a reliance on private wells for drinking water supplies. EPA's 1977 Report estimates that counties where there are more than 50,000 subsurface disposal systems are susceptible to ground-water problems. Using 1970 statistics, twenty-seven counties in the U.S., covering about 50,000 square miles (about 1 percent of total U.S. land area), fit into that category.[1/] In addition, numerous other small communities across the U.S. have high densities of subsurface disposal systems. Although only a small fraction of this area may be affected, it is certain that the use of subsurface disposal systems by 20 million housing units in the U.S. does pose a potential threat to regional ground-water quality.

[1/] 1977 Report to Congress, p. 194; U.S. Department of Commerce, Bureau of the Census. County and City Data Book 1977.

Contamination from Petroleum Exploration and Mining Activities

Several different activities related to petroleum exploration have caused substantial contamination problems in states in the south central and southwest United States. Although no full account of the problem is available, seventeen states have located and documented ground-water contamination problems. In Texas alone, 23,000 cases of ground and surface water contamination have been reported. One of the major causes of contamination, the use of brine pits to dispose of saline by-products of drilling, is now almost universally banned in producing states. Nevertheless, the contamination caused by the use of brine pits for more than eighty years has limited the use of ground water in many areas and surface impoundments continue to be used for temporary storage and other activities. The Surface Improvement Assessment identified nearly 70,000 active petroleum production impoundments, more than twice the number of industrial impoundments. In addition, abandoned and poorly maintained producing wells and injection wells are other potential contamination sources.

As was the case with petroleum exploration, the mere presence of mining activity in a region significantly increases the possibility of ground-water contamination. There are more than 17,000 active coal, metal, and non-metal mines in the United States. Every mine poses a contamination threat but little research has been done on mine-related contamination; in many mining areas, ground-water contamination is an accepted fact of life. Contamination problems are caused not only by waste disposal sources, such as slurry lagoons, tailings ponds, and slag piles, but also by activities such as mine dewatering and failure to undertake land reclamation. The SIA identified approximately 25,000 mining impoundments; like petroleum impoundments, these can be expected to add to the total area of estimated ground-water contamination in the nation.

Table 3 presents data on the number of active surface impoundments and surface impoundment sites in the U.S. The data indicate that there are three times as many oil, gas, and mining impoundment sites as there are industrial impoundment sites. If these impoundments contaminate usable aquifers to the same degree industrial impoundments do, then about 0.1 percent of nation's usable (surface) aquifers are contaminated by these sources.

TABLE 3

ACTIVE SURFACE IMPOUNDMENTS IN THE U.S.

	Number of Impoundments	Number of Sites*
Industrial	24,483	10,495
Municipal	32,669	17,233
Agricultural	18,570	14,147
Mining	23,976	6,902*
Oil & Gas Brine Pits	66,655	25,120*
Other	6,645	1,781
	172,998	75,678

*SIA estimates for the mining and oil and gas brine pit sites are not necessarily related to actual ownership and should not be referred to as the actual number of legal sites.

SOURCE: 1980 SIA survey

Preliminary Conclusions on the Extent of Ground-Water Contamination

This analysis has developed some preliminary estimates of the amount of contamination caused by the most important sources of ground-water contamination. Industrial impoundments and landfills appear to have contaminated 0.1 to 0.4 percent of the Nation's usable (surface) aquifer area. Subsurface disposal systems appear to have contaminated significantly less than 1 percent of usable aquifer area, and oil, gas, and mining impoundments may have contaminated 0.1 percent of the nation's usable aquifer area. Other waste disposal activities (e.g., injection wells) have also contributed to aquifer contamination. Consequently, this preliminary assessment of ground-water contamination suggests that up to 1 percent of the area of usable surface aquifers in the United States may be contaminated at the present time as a result of industrial and other waste disposal activities. The area of these plumes of contamination will, of course, increase with time.

Additional analysis is required to improve this estimate and to examine the amount of contamination caused by non-disposal related activities. Additional analysis is also required to determine to what degree the areas where ground water is contaminated overlap the areas where ground water is currently used or will be needed for water supplies in the future.

APPENDIX IV

SYNTHETIC ORGANIC CONTAMINATION IN GROUND WATER

SYNTHETIC ORGANIC CONTAMINATION IN GROUND WATER

Drinking water drawn from the ground has generally been viewed as a pristine resource, unspoiled by human activities. Typically, major treatment is not considered necessary and treatment is generally not utilized by the over 100 million people using ground water as their source of drinking water. Traditionally, the focus has been on the contamination of surface waters by wastewater discharges, industrial discharges, and diffuse source run-off. Health regulatory agencies have been most concerned that treatment systems and careful monitoring were employed by public water systems using surface water for protection of human health against the bacterial contamination and, more recently, organic chemicals contamination.

Recent information, however, has shown that many ground waters are also contaminated with organic chemicals. The contamination of ground water is now recognized as a serious problem and a potential health hazard to millions of consumers. Contamination has been most commonly found in urbanized or industrial areas and is the result of improper disposal of hazardous waste, industrial activities and possibly subsurface disposal system discharges. Unlike surface waters, ground waters do not have a natural cleansing mechanism, and once contaminated, ground waters will generally remain contaminated.

EVIDENCE OF CONTAMINATION

To date a relatively small but rapidly growing effort has been expended to obtain a clear view of the level to which synthetic organic chemicals have become contaminants of potable water drawn from the Nation's ground waters. We now know that ground waters can be contaminated with significant levels of both natural and synthetic chemicals that are toxic. Toxic chemicals such as arsenic, barium and radionuclides are often related to the natural chemicals in the soil, whereas contamination with synthetic organic chemicals is generally associated with places where those chemicals are made, spilled, used or disposed. Pesticides such as DBCP, Aldicarb and Carbonfuran have been found in farm wells. Trichloroethane, trichloroethylene, freon, acetane, xylene, dimethyl sulfoxide, trimethyl silanol, chomium, arsenic, lead, zinc, chloroform, methylene chloride, benzene, toluene, ethyl benzene, fuel oil, vinyl chloride, 1,2-dichloroethane, tetrachloroethylene and many other organic compounds have been found in highly contaminated wells. (Table 1)

To date 44 communities in Massachusetts have had their public water supply severely contaminated with one or more synthetic organic compounds: 16 incidents have occurred in Connecticut, 25 in Pennsylvania, 12 in New York, and 1 or more in each of 20 other states.

For example:

Wells Closed as a Result of Chemical Contamination in Gray, Maine

In September of 1977, the McKin Company was ordered to close by town officials of Gray, Maine, due to drinking water well contamination associated with the site. The facility was built in 1972 to handle waste oil from the "Tamano" oil spill in Casco Bay. From 1972 until 1977, its primary operation was as a transfer station for fuel still bottoms. Materials stored in existing tanks were mixed together for final shipment to refiners. Approximately 100,000 to 200,000 gallons were annually processed by McKin at the Gray site.

There was evidence that wastes were spilled at the processing facility and leached into the aquifer. An unpleasant taste and offensive odors in the drinking water were reported in 1974. Samples of drinking water were submitted to the state laboratory for testing, but the contaminants were not identified. When the well water discolored laundry, residents started turning to alternate sources for their water supply.

In 1977, trichloroethane, trichloroethylene, freon, acetone, xylene, dimethyl sulfide, trimethylsilanol, and alcohols were identified. Toxic organics were detected in eight domestic wells within 2,000 feet of the McKin Company. As a result, the town health officer ordered sixteen contaminated wells in the area capped. Traces of these same chemicals were also discovered in the town's public water supply where contaminants are thought to have leached into the water table from the town dump where the company disposed of its chemical wastes.

TABLE 1

A LISTING OF ORGANIC CHEMICALS IN FINISHED WATER

Surface	Frequency %	Ground	Frequency %
Chloroform	99.6	Chloroform	70.3
Bromodichloromethane	95.0	Bromodichloromethane	69.2
Chlorodibromomethane	79.3	Chlorodibromomethane	64.5
Pentachlorophenol	38.1	Bromoform	36.3
Diethyl Phthalate	36.1	Dichloroiodomethane	30.3
Dichloroiodomethane	35.2	Dibutylphthalate	28.6
Dibutyl Phthalate	33.3	Tetrachloroethylene	26.1
Atrazine	27.8	1,1,1-Trichloroethane	22.2
2,4-Dichlorophenol	21.8	1,1-Dichloroethane	21.4
Benzene	21.6	cis-1,2-Dichloroethylene	21.4
Phthalic Acid	20.4	Phthalic Acid	21.4
Toluene	19.4	2,4-Dichlorophenol	17.2
Tetrachloroethylene	17.8	Trichloroethylene	16.4
Carbon Tetrachloride	16.0	Diethylphthalate	14.3
Trichloroethylene	15.5	p-Dichlorobenzene	12.9
Simazine	13.0	bis(2-Chloroethyl)Ether	8.7
p-Dichlorobenzene	12.5	Benzene	8.5
Bromoform	12.4	Ethyl Chloride	7.1
1,3,4-Trichlorobenzene	11.5	Trichlorofluoromethane	7.1
Dichloromethane	10.0	1,1-Dichloroethylene	7.1
1,1,1-Trichloroethane	9.9	Trans-1,2-Dichloroethylene	7.1
Disulfoton	9.2	Chlorobenzene	7.1
Benefin	9.2	Simazine	7.1
Malathion	6.5	Methyl Parathion	7.1
Fluoranthene	5.8	Malathion	7.1
Phenyl Acetic Acid	4.6	Pentachlorophenol	6.9
Cyanazine	4.6	Fluoranthene	6.9
Propazine	4.6	Dichloromethane	6.7
cis-1,2-Dichloroethylene	4.6	Carbon Tetrachloride	5.5
Trichlorofluoromethane	4.6	bis(2-Chloroisopropyl)Ether	4.3

Jackson Township, New Jersey

The municipal landfill was licensed by NJDEP in 1972 to accept sewage sludge and septic tank wastes. However, chemical dumping allegations have been confirmed by chemical analysis of underlying ground water. The landfill was recently closed to all wastes.

The landfill abuts the Ridgeway Branch of Toms River, and overlies the Cohansey Aquifer, the sole source of drinking water for the surrounding residential community. The soil is composed of porous sands and no natural or manmade liners exist. Over 100 residences used private water wells within 1.5 miles of the site. Water is now trucked to the community.

Approximately 100 drinking water wells surrounding the landfill have been closed because of organic chemical contamination. Analysis of water samples has shown the presence of chloroform (33 ug/l) methylene chloride (3,000 ug/l), benzene (330 ug/l), toluene (6,400 ug/l), trichloroethylene (1,000 ug/l), ethylbenzene (2,000 ug/l) and acetone (3,000 ug/l). Residents claim that premature deaths, kidney malfunctions, kidney removals, recurrent rashes, infections and other health-related problems are due to the contamination of their water supplies by the landfill. Although use of the water wells has been banned, residents are still using well water because no other dependable source of water exists.

Ground-Water Contamination Beneath the Rocky Mountain Arsenal

Rocky Mountain Arsenal, jointly operated by the U.S. Army Chemical Corps and Shell Chemical Company, is located between Denver and Brighton, Colorado. Over the years the facility has disposed of a complex mixture of chemical by-products from the manufacture of pesticides and herbicides, along with other wastes during the years 1943-1957. Originally, wastes were disposed of in unlined holding ponds, a practice which led to infiltration into the shallow water table aquifer and the consequent migration of contaminants through the ground water. Although this practice was discontinued in 1957, extensive ground-water contamination is still very much in evidence.

To date, thirty square miles of the shallow water table aquifer are contaminated, resulting in the temporary abandonment of a number of domestic, stock, and irrigation wells, and final abandonment of two wells.

Soil in the vicinity of one pond is contaminated by the pesticides aldrin and dieldrin. Classified as cyclodienes, these compounds are derivatives of hexachlorocyclopentadiene. They bioaccumulate in the fatty tissues of terrestrial and aquatic organisms and tend to persist in the environment over long periods. These pesticides are quite toxic.

Long-Term Pollution Problems Associated with Creosote Production in St. Louis Park, Minnesota

For 50 years, Reilly Tar and Chemical Company and Republic Creosoting Company operated on an 80-acre site in St. Louis Park, a western suburb of Minneapolis. Reilly Tar and Chemical refined coal tars to produce creosote, and Republic Creosoting then used the material to treat wood products. While the operation supposedly included discharge of waste products into a ponding area on the property, there were apparently numerous cases of spills, leaks, pipeline breaks, and burial of wastes over the years.

The site has a long history of pollution problems. As early as the 1930s, some drinking water wells in the area were closed due to a tarlike taste. In 1969, low levels of possible carcinogens were found in a ground water investigation for the city. The Minnesota Pollution Control Agency ultimately brought suit against the generators in 1970, and in 1971 the operations were closed.

Several years of study have revealed the extensive contamination that the St. Louis Park plant has caused. Analyses have documented the presence of phenols and three polynuclear organics--phenanthrene, chrysene, and pyrene. Low phenol concentrations have also been found in wells further than one mile off the site. Certain drinking water supplies have already been closed. This incident illustrates the capability of pollutants to migrate with the ground-water flow.

NATIONAL PERSPECTIVE

Thirty-nine cities using ground water have been tested in Federal surveys to determine how frequently volatile chlorinated solvents contaminate finished drinking water. As of March 1980, over 8000 chemical determinations for volatile organics had been performed on well water by some State Agencies. Most of the state data focuses on "hot spots" of pollution and provides a "worst case" of ground-water contamination nationwide.

Systematic data based on representative samples is not available. The findings of both State and Federal monitoring efforts are summarized below.

Trichloroethylene

Trichloroethylene (TCE) is a high volume industrial chemical which is used extensively as a solvent for degreasing metal. In 1973 over 451 million pounds of this chemical were produced in the United States. Based on high dose animal studies performed by the National Cancer Institute, TCE was found to be carcinogenic in mice.

Trichloroethylene has been detected in ground water from 16 states across the United States. Data obtained from Federal monitoring programs indicate that over 30 percent of the 25 public drinking water supplies sampled contained levels of this contaminant. These data show that contaminated supplies contained from 0.11 to 53 ug of trichloroethylene per liter of finished water. The rate of discovering contamination in wells varies from state to state. Seventy-nine percent of the wells (19) tested in Delaware have been found to be contaminated whereas only 2 percent of the 1200 wells tested in Connecticut contained traces of the chemical. A national summary of 2,984 samples of well water from 8 states reveals that nearly 1 out of every 3 drinking water supplies contain measurable amounts of trichloroethylene. The highest level of trichloroethylene reported in well water was 35,000 ug/l.

Carbon Tetrachloride

Carbon tetrachloride is one of the volatile organic compounds that has been found more frequently in finished water than in raw, untreated water. Over 1 billion pounds of this compound were produced in the United States in 1973. It is used as a cleaning solvent, pesticide and intermediate in the production of chlorofluoromethanes.

Carbon tetrachloride is rapidly absorbed through the gastrointestinal tract and the lungs. Exposure to high levels of this chemical can cause damage to the kidneys and liver. In an NCI test, mice exposed to high levels of carbon tetrachloride for their lifetime developed an increased incidence of liver cancer.

Twenty-eight percent of the 39 finished ground waters tested in Federal surveys were found to be contaminated with carbon tetrachloride. The levels of contamination ranged from 0.2 to 13.0 ug/l with a national average of 3.8 ug/l. This chemical has been found in chlorinated ground waters serving as public drinking water in many states. It is believed that the presence of carbon tetrachloride in finished water is largely due to impurities in the chlorine used as a disinfectant. This theory is substantiated by the knowledge that only 7 percent of the raw water drawn from underground sources has shown the presence of carbon tetrachloride.

Tetrachloroethylene

Tetrachloroethylene is a solvent that is widely used in dry cleaning and degreasing operations. In 1973 over 700 million pounds of this industrial chemical were produced in the United States. Animal tests show that mice exposed to this compound for a lifetime have an increased incidence of liver cancer.

Data from Federal studies indicate that 18 percent of raw water being used by the 27 community systems tested in the United States contained tetrachloroethylene. While the treatment processes used by most contaminated public systems do reduce the level of contamination slightly, most of this chemical does reach the consumer. The level of contamination found in finished drinking water ranged from 0.2 to 3.1 ug/l in that survey.

Tetrachloroethylene has been shown to be an accidental additive to drinking water coming in contact with resin-lined asbestos cement pipe. Concentrations as high as 3,500 ug/l have been reported in drinking water supplies using this type of pipe in their distribution system. Twelve states have reported efforts to determine if tetrachloroethylene contamination has occurred in their aquifers. Positive samples were taken from over 60% of the wells.

1,1,1 Trichloroethane

1,1,1 Trichloroethane is also known as methyl chloroform. It is widely used as an industrial cleaner and degreaser of metals, resin adhesive, and vapor pressure depressant. In 1978 over 600 million pounds of methyl chloroform were produced in the United States. Methyl chloroform is not considered to be a carcinogen.

State authorities in New York, New Jersey, Alabama, Florida, Idaho, Maine, Massachusetts, North Carolina, Tennessee and Washington have reported finding from 1 percent to 69 percent of their wells positive. Concentrations as high as 2,250 ug/l have been detected in highly contaminated wells. Federal surveys indicate that 21 percent of the 23 public water supplies tested using ground water are contaminated with 1,1,1-trichloroethane. Consumers of this water would, on the average, be ingesting 2 ug of 1,1,1-trichloroethane per liter of water.

1,2 Dichloroethane

In 1977 over 4 million metric tons of 1,2-dichloroethane were produced in the United States. The major use of 1,2-dichloroethane (EDC) is as a raw material for the production of vinyl chloride. However, every gallon of leaded gasoline produced in the United States contains EDC as a lead scavenger. This chemical is also used as a solvent for paints, cleaning solvent and grain fumigant. NCI reports continuous exposure to high levels of EDC causes cancer in animals.

EDC has been reported as a contaminant in well water analyzed from eight states. The preponderance of these positive samples was collected from states along the eastern seaboard of the United States. The analysis of 1,200 water samples by State agencies has shown this chemical to be a contaminant of finished drinking water in 7 percent of the sample. A maximum concentration of 400 ug/l has been recorded. Data from Federal surveys show that 4 percent of the 25 ground-water supplies sampled contained this pollutant. The average concentration in contaminated wells is approximately 0.2 ug/l.

1,1-Dichloroethane

1,1-Dichloroethane is not reported to be produced commercially in the United States but is imported for use as a solvent and cleaning agent in specialized processes. Very little information is available on the toxicity of 1,1-dichlorethane.

1,1-dichloroethane has been detected in 23 percent of the samples of the 13 ground waters examined during Federal monitoring programs. The contaminant has been reported to be present in well water from Alabama, Colorado, Florida, Massachusetts, North Carolina, Pennsylvania and Tennessee. The highest level of 1,1-dichloroethane reported to be in drinking water was 11,330 ug/l. An average concentration of 0.3 ug/l 1,1-dichloroethane has been computed for contaminated wells.

Dichloroethylenes

Dichloroethylenes are a group of 3 isomers. Cis 1,2-dichloroethylene and Trans 1,2-dichloroethylenes have not had wide industrial usage; 1,1-dichloroethylene has found a place in the market. In 1976 it was estimated that 120,000 metric tons of 1,1-DCE were produced in the United States. 1,1-dichloroethylene is used as a chemical intermediate for the production of methyl chloroform.

Very little information is available on the toxicity of Cis and Trans 1,2-dichloroethylene. 1,1-dichloroethylene has been more widely studied. Exposure to high levels of the 1,1 isomer can have adverse effects on the kidney and liver. Although tests on the carcinogenicity of this compound are not yet complete, preliminary data from Maltoni indicates that test animals are experiencing an increased incidence of kidney and mammary cancer.

Cis 1,2-dichloroethylene has been detected in 30 percent of the 39 finished ground waters sampled in Federal surveys. The trans and 1,1 isomers have been detected in 15 percent and 7 percent of the wells tested. State Agencies report that as much as 860 ug/l of "dichloroethylenes" have been found in highly contaminated water supplies.

Methylene Chloride

Methylene chloride is used in the manufacture of paint and varnish removers, insecticides, solvents, pressurized spray products and Christmas tree bubble lights. In 1973 over 1/2 billion pounds of methylene chloride were produced in the United States. Exposure to methylene chloride produces an elevation of the blood carboxyhemoglobin in humans. Exposure to high levels results in the formation of large amounts of carbon monoxide in the body and central nervous system impairment.

Two percent of the 1,180 wells examined by State agencies have revealed the presence of methylene chloride. Concentrations as high as 3,600 ug/l have been recorded. Federal studies indicate that, on the average, consumers of water from contaminated wells would be exposed to a concentration of 7 ug/l of water ingested.

Vinyl Chloride

Vinyl chloride has been used for over 40 years in producing polyvinyl chloride, which is the most widely used material for the production of plastics. In 1975 nearly 5 billion pounds of vinyl chloride were produced in the United States. Continuous exposure to vinyl chloride has been shown to produce cancer in humans. Vinyl chloride has been detected in nearly 16 percent of the 13 raw waters tested in Federal surveys. However, it appears that because of its volatility much of this contamination never reaches the consumer. Seven percent of the 1,033 wells tested by State agencies have been positive for vinyl chloride. Concentrations as high as 380 ug/l have been reported.

EXPOSURE TO MULTIPLE POLLUTANTS

The ability to look for a specific pollutant or classes of pollutants is excellent, but it is impossible to detect the presence of all contaminants in a water sample. The specific list of compounds that are detectable in drinking water is severely limited by the methods of isolation and detection that are available. Many compounds have been detected in finished well water. The list presented in Table 1 is a partial representation of the chemicals found thus far. Intensive surveys conducted by State agencies have added to our perception of the magnitude of the ground-water contamination problem. Phthalates, toluene, ethylbenzene, benzene, and other compounds have frequently been found in well water from New York (Table 2). Dichlorobenzene, trichlorobenzene and iodomethane have been reported from New Jersey (Table 3). The national scope of contamination by these chemicals is unknown. However, polluting ground water with a single pure chemical is unlikely. It is far more probable that contaminated wells will be affected by multiple pollutants simultaneously. Information on the volatile organic compounds substantiates this hypothesis. Sixty percent of the 39 ground-water supplies tested in Federal monitoring programs contained either trichloroethylene, tetrachloroethylene, 1,1,1-trichloroethane, 1,1-dichloroethylene, 1,2-dichloroethylene, carbon tetrachloride, 1,2-dichloroethane, 1,1-dichloroethane, methylene chloride or vinyl chloride. Slightly over one half of contaminated water supplies contained one of these industrial solvents. Ten percent of the potable waters tested contained two of these compounds. Another ten percent contained three of these chemicals and twenty-three percent were found to contain four of these toxicants simultaneously.

The toxicity associated with simultaneous exposure to more than one of these compounds is unknown.

TABLE 2

THE TEN MOST COMMONLY FOUND ORGANIC CHEMICALS DETECTED IN NEW YORK PUBLIC WATER SYSTEM WELLS--10/78

Contaminants	Wells Tested	Wells Positive	Percent Positive	Maximum Level Detected (ug/L)
Bis(2-Ethylhexyl)Phthalate	39	36	92	170.0
Toluene	39	33	85	10.0
Di-N-Butyl Phthalate	39	21	54	470.0
Trichloroethylene	39	18	46	19.0
Ethylbenzene	39	17	44	40.0
Diethyl Phthalate	39	13	33	4.6
Trichlorofluoromethane	39	11	28	13.0
Anthracene/Phenanthrene	39	7	18	21.0
Benzene	39	6	15	9.6
Butyl Benzyl Phthalate	39	5	13	38.0

TABLE 3

REPORTED FINDINGS IN NEW JERSEY GROUND WATER SURVEY--PARTIAL

# of Samples	Chemical	% Positive	Frequency Distribution (ug/L) <1.0	1-10	10-100	>100
Trihalomethanes						
399	Chloroform	35	337	52	5	3
393	Bromoform	4	390	2	1	0
227	Dibromochloromethane	8	226	1		
Volatiles						
397	1,1,2-Trichloroethylene	73	337	41	15	4
394	1,1,2,2-Tetrachloroethane	6	393	1		
394	1,1,2-Trichloroethane	10	376	17	1	
394	Carbon Tetrachloride	24	335	57	1	1
397	1,2-Dibromomethane	4	391	2	4	
391	1,2-Dichloromethane	2	387	4	1	
399	1,1,1-Trichloroethane	66	203	141	55	1
397	1,1,2,2-Tetrachloroethylene	23	348	34	15	
717	Dichlorobenzene	1	710	4	3	
396	Trichlorobenzene	3	383	10	3	
397	Iodomethane	12	395	2		

The following chemicals were not found: Methyl Chloride, Methyl Bromide, Vinyl Chloride, Methoxychlor, Methylene Chloride, Trifluoromethane, Toxaphene.

APPENDIX V

ANALYSIS OF STATE AND FEDERAL PROGRAMS BY POLLUTANT SOURCES

ANALYSIS OF STATE AND FEDERAL PROGRAMS BY POLLUTANT SOURCES

This paper discusses the major sources of pollution to ground water, describes the current Federal and State programs for controlling these pollutants and the related institutional relationships, and poses key policy questions for consideration.

LANDFILLS, DUMPS AND SURFACE IMPOUNDMENTS

Over 16,000 landfills in the United States receive approximately 230 million tons of wastes per year. Leakage of contaminants to ground water is estimated at 90 billion gallons per year. Toxicity of wastes stored varies widely. It is estimated that 638 landfill/dumps may contribute substantial quantities of hazardous wastes which could cause significant, imminent hazard to public health and the environment.

The States have initiated the open dump inventory required under RCRA which is projected to be completed in five years. More recently, EPA has initiated the hazardous uncontrolled and abandoned waste site program. EPA will rank uncontrolled waste sites, investigate sites which pose the greatest threat and initiate emergency assistance and containment actions at most critical sites.

Under the Surface Impoundment Assessment (SIA) under SDWA, the EPA gave grants to States to locate all surface impoundments and assess at least a random sample of impoundments, using a standardized system to determine their potential for causing ground-water pollution. Over 180,000 impoundments have been located and in excess of 30,000 impoundment sites have been assessed as of April, 1980. It was observed that 97 percent of the respondants did not know if there were significant changes in ground water. For the 25,000 industrial impoundments, 94 percent have no monitoring wells, 66 percent have no liner, 58 percent are sited over sand/gravel or fractured rock aquifers and 52 percent have a relatively high waste hazard potential.

This inventory will serve as a first round approximation to help the RCRA inventory of open dumps and the hazardous and abandoned site program set priorities and to provide a basis for the States to develop regulatory programs under RCRA, and for EPA to implement the Superfund legislation.

Currently RCRA regulations are being completed. The regulations will establish standards for the listing of hazardous wastes, and standards for generators, transporters and for operators of treatment and disposal facilities. The program requires monitoring, a manifest system and a facility permit system.

EPA may delegate the administration/enforcement of the hazardous waste programs to the States. A State may seek interim authorization of up to two years if the State has a hazardous waste program in effect with sufficient legislative authority, regulations in effect and adequate resources to administer and enforce the program which are substantially equivalent to the Federal program.

Guidelines for solid waste management plans under RCRA have been published addressing the implementation of the management of solid waste (non-hazardous) through resource recovery or environmentally sound disposal, including the closing and/or upgrading of open dumps.

At this time, the Superfund legislation is proposed in Congress which will address releases to the environment of oil and hazardous substances, and hazardous wastes from spills and from inactive and abandoned disposal sites. It establishes a comprehensive and uniform system of notification, emergency government response, enforcement, liability and compensation. The proposed legislation establishes a fund to assure monies to carry out the authorities. The fund would be raised from Federal appropriations and an industry-based fee. The fund would raise approximately 1.3 billion dollars over a four year period. The proposal would authorize EPA to make grants to States, or enter into contracts or cooperative agreements to respond to spills.

In many States, there has been a lack of clear and specific authority to regulate on-site industrial disposal sites. Several States also have difficulty in enforcement because of local government jurisdiction. The Superfund legislation should assist in resolving these issues by clarifying the responsibility for waste handling and disposal. Superfund will also provide a source of funding to contain major ground-water contamination problems.

Issues:

How will proposed policies on delegation and interim authorization for State's management of the hazardous waste program affect timing and resource requirements? What are options if several States refuse or fail to participate in the program?

What should be the Federal role in disposing of wastes if adequate sites cannot be found or are not politically acceptable? What should be EPA's policy on closing dumps or lagoons, requirements for new sites prior to closing facilities and upgrading bad dumps.

What is our ability to rehabilitate or control hazardous waste sites? Impact on criteria for allocation of Superfund monies?

ON-LOT DISPOSAL SYSTEMS

Over one-fourth of the United States households use on-lot disposal systems which discharge over a trillion gallons of wastes per year to the subsurface. There are many existing and potential problems with malfunctions of these systems, which has resulted in the belief that on-lot systems are inadequate treatment facilities. On-lot systems can be effective treatment systems if properly designed, constructed, operated and maintained, and if drainage fields are located in appropriate soils.

Density of on-lot systems, especially those in the urban fringe areas, can also affect ground-water quality. Few State or local regulatory programs include density controls for protection of ground water.

New York, Connecticut and Pennsylvania have attributed chlorinated hydrocarbon ground-water contamination to the use of solvents to clean plumbing and septic tanks. These degreasing products and drain-opening products are potentially a large non-industrial source of contaminating solvents. In most occurrences of chlorinated solvent contamination, industrial activities have been implicated as a source of the chemicals. The full extent of the role of consumer products and other chemicals disposed of or used in septic tanks has not yet been fully determined.

Control of on-lot systems is usually contained in some basic authority of a State agency. Local or county governments administer the program under State regulations and supervision. Regulations generally control the siting, design and construction of the systems but do not specifically require maintenance. Many communities also lack proper control of septage disposal. In addition, regulations are not directed to the control of industrial wastes disposal or density controls to protect ground water.

The Clean Water Act of 1977 established funding eligibility for the construction, rehabilitation and/or upgrading of on-lot wastewater disposal systems for individual homes and small businesses as a part of the Construction Grants program. This change to the law resulted from the realization of the high cost of construction of conventional wastewater collection and treatment works in low-population density areas. The CWA regulations require detailed economic and environmental studies as part of the justification for funding of any construction project.

The 208 grant program has provided funding for evaluation and revision of on-lot system regulations, for establishing agreements between jurisdictions on administration of on-lot regulations and disposal of septage wastes, as well as site-specific impact assessments and control options of on-lot systems, and determining financing alternatives for replacing malfunctioning systems. Several ongoing projects are evaluating alternatives for controlling densities (i.e., Spokane-Rathdrum Prairie Aquifer in Washington and Idaho, designated as a sole sources aquifer, is utilizing 208 funds to examine densities of on-lot systems).

EPA has developed technical evaluations of controls and currently is evaluating management alternatives. EPA has held a number of technical seminars to provide assistance and currently is preparing an on-lot strategy dealing with issues such as 201/208 funding criteria, technical assistance and research needs.

Issues:

What should EPA's role be in requiring minimum on-lot disposal design or performance standards? Should EPA/States restrict the use of septic tank degreasers?

What methods can State and local governments use to provide adequate levels of manpower to administer existing programs? What are options for Federal incentives? Should EPA require minimal level of on-lot disposal State management? Should SMSA's manage on-lot systems as well as operations of POTW through user charge system?

Should policy directives through 201 program and user charge system requirements be used to minimize use of on-lot systems in urban fringe areas?

What are the options for developing density limitations and design critera?

UNDERGROUND STORAGE TANKS AND PIPELINES

Spills and leaks from pipelines and underground storage tanks are frequent sources of ground-water contamination; leaks, however, are exceedingly difficult to detect and locate.

Storage tanks and transmission lines which store and transmit hazardous materials will be under the control of RCRA. This control, however, will be limited because most materials involved are not classified as hazardous by RCRA, e.g., petroleum. For pipelines constructed with 201 grant dollars, there are existing standards for location, design and construction as well as inflow and infiltration analyses requirements.

Several States have assessed problems and operational programs dealing with storage tanks, e.g., New York is developing a program that will require periodic inspection including pressure testing and careful monitoring of fluid levels. While some jurisdictions have standards for storage tank construction, many do not have inspection programs for existing facilities and may have access problems for inspections.

Issue:

What options exist for Federal and State programs to control problems resulting from underground storage tanks and pipelines?

ACCIDENTAL SPILLS

The National Oil and Hazardous Substances Pollution Contingency Plan provides for Federal interagency response, including EPA and other Federal agencies. Spill response in inland waterways is provided by EPA Regional Offices. The U.S. Coast Guard is responsible for spills into coastal waters.

The Chemical Transportation Emergency Center (CHEMTREC) provides twenty-four hour advice on chemicals involved in spills. The National Agricultural Chemical Association provides personnel, equipment and expertise for cleanup of Class B poison pesticides.

RCRA and Superfund will provide authorities and funding to deal with hazardous waste spills. States will be required to develop adequate legislation and management capability prior to program delegation.

Issues:

> How can procedures and techniques for controlling spills be applied to ground water?
>
> What should be the Federal role, if States refuse or fail to develop adequate spill response programs?

RADIOACTIVE WASTE DISPOSAL

The Nuclear Regulatory Commission (NRC) has the responsibility for control of radioactive pollutants from milling facilities and from disposal practices. Mills processing radioactive materials produce highly acidic liquid slurries which are contaminated with chemical and radioactive pollutants, e.g., ammonia, nitrates, heavy metals, uranium. Mills generally have large tailing piles containing these wastes, but often do not have adequate monitoring programs.

The Uranium Mill Tailings Radiation Control Act of 1978 establishes authorities for control of milling operations. NRC has established a regulatory program which requires licenses for new mills and the relicensing of existing mills. Standards and BMPs (e.g., lined ponds, dewatering tailings to minimize seepage/runoff) are established by EPA.

NRC can delegate the regulatory program to States if they demonstrate a satisfactory health and safety program consistent with the NRC regulations and EPA standards. Currently, Colorado and New Mexico operate this program; Wyoming does not.

NRC requires an EIS on any new or revised license applications and will provide technical assistance in the preparation of the EIS. EPA prepares EIS's for the mills. The EIS's must address specific BMPs and the impact on ground water. NRC is currently producing a draft generic EIS on uranium milling. EPA gathers data on uranium milling and establishes standards.

In cooperation with the States, DOE will provide 90% funding for cleanup of inactive milling sites. Standards for this cleanup were promulgated April 22, 1980 by EPA (45 FR 27370).

High level radioactive wastes are not disposed of but are being stored in containment vessels by DOE. Approximately 75 million gallons of high-level nuclear wastes are in temporary storage. EPA is developing standards for disposal of these wastes; NRC will license disposal by DOE.

NRC has no authority over mining. However, problems result from the discharge of mine water and from the leachate created from tailings. Metal mines other than uranium are also causing problems. Little is known about the radiation problems occurring from titanium and zirconium mines. There is also radiation associated with copper ores and beryllium ores which recover uranium.

EPA/State has in some instances issued NPDES permits for mine discharge (e.g., New Mexico). The Mine Safety and Health Administration has authority to control mining hazards and to regulate wastes/products during the transport to the mill, but currently not much is being done regarding the impacts of mine wastes or the impacts of mining operations on ground water.

Mining wastes are being addressed by the continuing 208 program (see section on mining wastes). Generally, there are limited operational control programs over the problem.

An additional source of radioactive waste materials results from the mining and milling of radioactive phosphate ores. Fertilizer plants produce uranium wastes from phosphate host rocks. NRC only regulates these facilities if they are producing uranium commercially or if uranium is a fairly high percentage of material.

Issues:

> Do EPA standards and EIS procedures sufficiently address ground-water impacts? How should other ores that are causing radioactive problems, e.g., titanium, be dealt with?

AGRICULTURAL PRACTICES

Agricultural runoff is a problem in 68 percent of all hydrologic basins in the United States. Ground-water pollution resulting from agricultural activities is less documented. However, agriculture has a special dependency on ground water. Almost all of the Nation's rural households are supplied by wells, and most of these are single-family wells subject to few, if any, water quality safeguards.

Agricultural practices responsible for contamination of ground water are: irrigation return flow; application of chemical fertilizers or animal wastes; changes in vegetation; and use of pesticides. In the West especially, irrigated agriculture is both a victim and a cause of saline pollution; crop yields are reduced on one-quarter of the irrigated land in that region. The process of irrigation, which concentrates salts by evapotranspiration and adds others by leaching from soils, can introduce chloride and other substances into a ground-water reservoir. Increased salinity in irrigation water may also decrease crop production by affecting crops sensitive to salinity and by changing the productive characteristics of soils.

Ground-water pollution by pesticides has not been detected as frequently as surface water pollution because of the transit time through the soil. The problem is more prevalent in areas of high water tables, in fracture zones, or in immediate vicinity of wells. The increase of concentration of contaminants in ground water from use of fertilizers is a more frequent problem.

EPA regulates pesticides under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA). EPA's registration and labeling programs are preventive in nature. The certification of pesticide applicators and the pesticide use enforcement program are generally delegated to the States or the state department of agriculture.

High nitrate content is reported in ground water in many agricultural areas. As an example, Nebraska is examining ways to control the increasing nitrate levels in its ground water resulting from agricultural activities. BMPs include optimizing fertilizer application, timing nitrogen application, using crop rotation, using animal wastes for fertilizer, and plowing-under green legume crops.

The generation and disposal of large quantities of animal waste at locations of feeding operations can pose ground-water problems if improperly contained. There are several potential contaminants in manure, but nitrate is the one most frequently encountered in ground water. Pathogens from the animal wastes can also contaminate ground water.

Concentrated animal feeding operations are regulated under the CWA and can be required to have a NPDES permit. Additional regulations are imposed by some States. Typically they are based on ratio of animals to land area. Larger installations generally have treatment facilities or lagoons, and in recent years there has been a trend to increase the use of manure as fertilizer.

EPA has developed an agriculture nonpoint source strategy to focus the 208 efforts toward solving the most significant problems in areas where water quality is affected most adversely. While implementation programs move ahead, EPA/States will undertake a limited, but comprehensive evaluation of the impacts of agricultural pollutants on water quality and the effectiveness of BMPs. The focus of the agriculture strategy is the ranking of critical areas based on surface water quality.

An important part of the strategy is an analysis of policy issues dealing with the Federal role in long-term agricultural pollution control. Issues include the comparative effectiveness of regulatory versus non-regulatory NPS control programs for agriculture, use of CWA Section 313 to accelerate implementation on public lands, additional incentive programs to promote BMP implementation and Federal policies which impact agriculture land use detrimental to water quality, e.g., farming marginal lands.

Issues:

> What should be the Federal and State role in ensuring that BMPs will be implemented? Should some form of a regulatory program be used if non-regulatory programs are ineffective?
>
> What are the alternatives and incentives for increasing use of manures and sludges in lieu of use of chemicals for fertilizers?

SALT WATER ENCROACHMENT

Salt water intrusion into fresh water aquifers has become a major problem. The saline water may come from the sea or from inland saline aquifers. Overdraft of a fresh water aquifer can cause reversal or reduction of the density gradient which keeps the saline water in place. Salt water can then move into the remaining fresh water body.

Contamination of wells with sea water is a major problem in the Gulf Coast area, California and New England. California has established programs to reverse the movement of saline water through the use of barriers created by injection of non-saline water. Two communities, Ventura and Monterey are currently evaluating measures for controlling ground-water withdrawal to prevent additional salt water intrusion.

More than two-thirds of the United States is underlain by water containing more than 1,000 mg/l of dissolved solids and many inland fresh water aquifers are hydraulically connected with saline ground water. In most cases, the heavier, mineralized water underlies the fresh water. Where wells are too deep or where excessive pumping modifies the hydraulic gradient, saline water may be drawn into zones formerly containing fresh water.

Examples of saline intrusion in inland States include various locations in New Mexico and the Red River Valley of North Dakota, where vertical intrusion of deeper saline waters into the producing aquifer occurs as a result of heavy pumping. Similar problems exist in northwest Minnesota, various locations in Michigan, and the Mount Vernon-West Franklin area of Indiana.

Issue:

What should be the Federal and State/local roles in developing data and management programs for salt water intrusion?

PETROLEUM EXPLORATION AND DEVELOPMENT

Petroleum exploration and development have caused ground-water contamination. There are several potential sources of contamination -- accidental spills, release of drilling fluids, corrosion inhibitors or gas and oil through well casings by poor well construction, and disposal of fluids brought to the surface in connection with oil and gas production. A major threat to ground-water quality is the disposal of brine.

In the past, brine was discharged to streams or unlined evaporation pits. There have been a large number of instances of ground-water contamination from these pits. It is impossible to estimate the total volume of brine discharged to these pits, particularly since many have been abandoned over the past decade.

Today, brine is disposed of by underground injection or by discharge into lined lagoons. Underground injection through new wells will be controlled by the UIC program. There are proposed EPA regulations which address BPT requirements for the "Oil and Gas extraction point source category." Protection of the ground water is not addressed directly as the regulations control oil and grease discharges.

RCRA contains the authority to regulate and prevent ground-water contamination from lagoons containing hazardous materials. Proposed Superfund legislation would provide authority for government response and enforcement on abandoned disposal sites.

Most of the 30 oil-producing States have adequate regulations, particularly with respect to casing requirements for well construction. Most regulatory agencies require steel casings grouted to the surface. An unregulated situation exists with improperly plugged exploration wells.

The problem of limited enforcement generally results from the limited funding and manpower availability to the regulatory agency.

Issues:

Do the proposed BPCT regulations contain sufficient controls or evaluations to protect ground water? How can EPA work with the States to enable effective delegation of Hazardous Waste Management Programs under RCRA? What are the impacts if a State doesn't take the program?

UNDERGROUND INJECTION WELLS

Injection wells are used for the subsurface disposal of industrial, municipal, nuclear and hazardous wastes and wastes associated with oil and gas production. Contamination is not only caused by direct injection into an aquifer but also by leakage of pollutants from the well head, through the casing or well bore or through fractures in confining beds.

An estimated 500,000 injection wells are in operation nationwide. These wells involve a broad variety of practices and have been categorized into five classes. (Table I)

TABLE I

UNDERGROUND INJECTION WELL CLASSIFICATION

CLASS	FUNCTION	NUMBER OF WELLS*
I	Industrial, municipal waste disposal, beneath deepest stratum containing drinking water source.	400
II	Disposal of fluids brought to the surface in connection with oil and gas production, or to increase recovery of oil or gas.	140,000
III	Injection of fluids for solution mining of minerals, to recover geothermal energy.	8,000

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*Estimates of well inventory.

IV	Hazardous waste disposal into or above strata that contain drinking water sources.	5,000-10,000
V	All other wells, i.e., air condition-return flow wells.	250,000-500,000

The Safe Drinking Water Act (1974) established the Underground Injection Control (UIC) program to prevent underground injection of wastes which endanger drinking water sources. States may assume primary enforcement responsibility for operating effective programs. EPA responsibilities include establishing national requirements, providing grants to States for developing and implementing the UIC program, and reviewing and approving State programs. EPA will administer a program only if a State chooses not to participate or fails to administer the program effectively.

Issues:

> How can EPA work with the States to enable effective delegation of the UIC program? What are the impacts and options if several States don't take over the program?

ABANDONED WELLS

It has been estimated that 1.2 million abandoned wells are located near the review areas for underground injection wells. The total number of abandoned wells is so vast that all will never be located.

A number of abandoned wells have caused ground-water contamination. Often, wells serving houses or buildings which are being demolished for redevelopment or construction of a highway are simply bulldozed over, often breaking surface casings and seals. The old wells become a direct route for pollutants such as highway deicing chemicals or wastewater from leaky pipelines to enter the underlying aquifer. Abandoned oil and gas wells also present problems to ground-water quality. For example, abandoned oil wells can discharge brine continuously, contaminating shallow fresh water aquifers. Abandoned gas wells can discharge brine when the gas reserve has been depleted and salt water has migrated to the wells.

There is a growing effort on the part of the States to have abandoned wells properly plugged. As examples, New York, Minnesota, California and New Jersey have developed regulations concerning the drilling and plugging of wells. In addition, it is difficult to locate abandoned wells if an owner connects to a municipal system in lieu of developing a new well. Permits are required for construction of new wells but there is no enforcement of correct closure. The most successful BMP, which is very expensive, is to grout the well to prevent entrance of surface water and inter-aquifer exchange.

Abandoned wells may also be convenient illegal disposal sites for wastes, particularly hazardous wastes. The manifest system being developed under RCRA will control the problem related to hazardous waste disposal. Although abandoned wells are a problem, improperly constructed wells are also sources of ground-water pollution. Many States established minimum standards for well construction and/or licensed well drillers.

Issues:

- What should be the Federal role in encouraging or mandating States to develop regulatory programs to properly plug abandoned wells? In locating abandoned wells in key or sole source aquifers and undertaking appropriate remedial action? In establishing minimum standards for new well construction?

HIGHWAY DEICING CHEMCIALS

The use of large amounts of soluble salts for road clearing during winter months has led to a significant number of cases of ground and surface water contamination.

Salt-laden runoff from roads can percolate into soils adjacent to highways and reach ground water. Rain falling on uncovered storage piles at highway maintenance garages can dissolve the salt and facilitate infiltration into shallow aquifers. The latter generally is considered to be a more serious problem because of the high concentration of chloride entering the ground-water system.

Because of the large amounts of salt spread and stored in the Northeast, water in many aquifers, especially sand and gravel deposits in the glaciated region, has shown a disturbing rise in chloride and sodium concentration. Complaints of salt contamination of water from individual wells are so common in New England that several States have established annual budgets to allow for replacement of affected wells.

There appears to be no practical substitute for highway deicing salts. Several States have addressed BMPs for controlling deicing salts, e.g., reducing quantities used and substituting sands when possible and enclosing salt storage piles. The Commonwealth of Massachusetts has developed a very active program. The program includes an education program for spreaders, a health program to detect high blood pressure, a program requiring BMPs for storage piles and a salt-spreading program which reduces the spreading rates of salt and the partial use of sand.

Issues:

> What should be the Federal role in encouraging States to develop programs in the use of highway deicing salts? How can key aquifer recharge areas be protected by limiting the spread or storage of deicing salts?

ARTIFICIAL RECHARGE

Artifical recharge includes a variety of techniques used to increase the amount of water infiltrating to an aquifer. Recharge by spreading stormwater runoff or treated wastewater effluent over the land is the major concern. Underground injection wells, particularly Class V wells, indirectly recharge ground water and are discussed in another section.

In the case of an artificial recharge, site-specific impacts that need to be considered include controlling the quality of the recharge water and controlling the water pressure so that adverse effects do not occur. In many communities, the construction of this type of structure has close scrutiny.

Land spreading of wastewater can pose a threat to ground water unless properly controlled. The Construction Grants program encourages spray irrigation of wastewater as an alternative treatment technique by providing economic incentives pursuant to the mandate of the Clean Water Act. Projects funded by the 201 program are required to evaluate impacts on ground water and to ensure protection of ground water as a source of drinking water.

Stormwater runoff can become polluted, particularly from urban debris and areas containing industrial stock piles. Protection from stock piles runoff can be provided by covering or by enclosing the materials. EPA is developing BMPs and requirements for industrial stock piles.

Urban runoff is being addressed by the Water Quality Management Program. Thirty cities are currently implementing BMPs and over the next three years will evaluate the impact on water quality and effectiveness of BMPs. The water quality assessments are being made on surface waters because most runoff in developed areas is discharged into surface bodies of water. However, a few areas (Long Island) are assessing various BMPs (vegetation, retention basins) which recharge ground-water supplies.

Issues:

> How can policies and procedures for assessing wastewater disposal on land ensure ground-water quality impacts are taken into consideration?

MINING WASTES

Ground-water contamination associated with mining operations is prevalent in the Northeast, and to some extent, in the Southwest regions. Most mining operations encounter ground water. Drainage of high mineralized water from mine workings can cause ground-water contamination.

Dewatering of mines to allow work to proceed below the static water level causes water levels to fall. Exposing these materials to the air can cause oxidation of the minerals.

Percolating surface water or rainfall entering a mine or surface waste pile leaches the minerals and may transport them downward to the water table. After a mine is abandoned and dewatering operations are suspended, the local water table rises through the oxidized minerals, accelerating the leaching. This causes abandoned mines, including strip mines, to be a greater source of ground-water contamination than operating mines.

In a study of ground-water quality in Appalachia, high iron and sulfate concentrations and low pH in ground water were traced to coal mining operations. In northwestern Pennsylvania, acid mine drainage moved downward from strip mines into underlying aquifers through abandoned oil and gas wells and rock fractures, increasing the iron and sulfate content of the ground water. Thousands of active and abandoned metal mines in the western United States contribute to acid drainage problems and other pollution impacts from metals.

Measures to correct drainage of poor quality water from abandoned mines are typically prohibitive in cost. They may include sealing of mine openings to prevent drainage and precipitation from entering, flooding with water to eliminate air contact with acid-forming minerals or chemical treatment of drainage water.

With both surface and underground mining, waste disposal from mining operations -- tailing piles and slurry lagoons are a potential source of ground-water contamination. Where aquifers underlie these sources, contaminated water can percolate to the ground water.

BMPs for active mines can be highly effective. BMPs include special handling of pollutants, e.g., isolation of problem materials, rapid stabilization of exposed soils, water management through diversion, terracing, drainway, etc., bore hole grouting and shaft sealing, preplanned flooding and avoiding post-mining gravity drainage.

The Surface Mining Control and Reclamation Act of 1977 administered by DOI requires the implementation of a strong water pollution control program of coal mining in all coal States (26 States). The program provides Federal monies for developing a State regulatory program, partial funding to control implementation and enforcement of the

State regulations, and an Abandoned Mine Reclamation Land (AML) Program, the latter from a fee on coal production. The projected need for coal mining pollution control is greater than 30 billion dollars. OSM is currently undertaking a three-year inventory of abandoned sites. The SCS under the USDA administers the RAMP program which is a rural abandoned mine program with cost-sharing funds provided.

Agreements are being developed between EPA and the Office of Surface Mining to eliminate duplication of NPDES and OSM permits. EPA must concur on each DOI approved State Coal Mining Regulatory Program.

Several State programs are currently being developed with mining and ground-water protection. Arizona is developing a program to manage both surface and ground-water impacts from mining, and New Mexico is developing a ground-water strategy to implement regulations in Albuquerque - Metro, Carlsbad and Grants Mineral Belt areas. Particular emphasis is directed to controlling the impacts of uranium mining on ground water.

The OSW recently initiated a $3 million program for monitoring ground-water pollution resulting from mining pollution. Two of the sites are located in New Mexico and Arizona. The purpose of the program is to develop data for the hazardous waste program under RCRA and to work with the industries to develop BMPs.

Issues:

> What should be the Federal role and the State role in ensuring that BMPs and a regulatory program will be implemented for non-coal mining activities?

SLUDGE MANAGEMENT USING LAND SPREADING

In the United States municipal sludge production amounts to about 5 million dry tons per year and volume of industrial sludge is much greater. This area was not delineated into a separate category because hazardous materials included in sludge, which has the greater impact on ground water quality, are addressed under RCRA and the pretreatment program. Stronger and more comprehensive source controls will encourage development of recycling/reuse and degradation technology.

One of the waste disposal problems which could have an effect on ground-water quality but was not specifically addressed in the previous sections is sludge management using land spreading. Ground-water degradation could be caused from the leaching and percolation of organisms and chemical ions and compounds.

APPENDIX VI

ANALYSIS OF EPA LAWS AND POTENTIAL APPLICATION TO GROUND WATER

VI-0

ANALYSIS OF EPA LAWS AND POTENTIAL APPLICATION TO GROUND WATER

The purpose of this analysis is to summarize EPA's legal authorities and programs which affect or may affect ground-water protection. It is not intended as a set of recommendations by EPA, but rather a tool to provide information and stimulate ideas. At the time this document was prepared RCRA and UIC regulations had not been promulgated, and, therefore, were not included in this analysis.

This analysis identifies each EPA law according to section or some other appropriate designation. These laws and sections are classified into six categories: policy, program development, regulatory, control technologies and standards, information development and transfer and emergency powers. Statutory language in each of the six categories has been analyzed for implementation of a proposed strategy. The status of implementation of authorities within each category is briefly set forth. This includes an identification of difficiencies or potential areas where improvement is needed.

POLICY

The major acts administered by EPA, along with NEPA, the President's Water Resources Policy Reform Message, and its July 12, 1978 memoranda of implementation contain policy statements that vary in their specificity and the extent to which they have been carried out in the area of ground-water protection.

RCRA, TSCA and FIFRA contain rather general statements of policy to protect health and environment. Use of these general policies to develop a ground-water protection strategy has been been minimal to date. Currently OPTS and the Office of Drinking Water have made arrangements to review the effect of new chemicals on ground water, and are developing regulations on solvents. Further efforts to incorporate ground-water emphasis in EPA Toxic Substances Priority Committee are anticipated.

A major SDWA policy is to protect underground sources of drinking water. This policy is being implemented by the development of the UIC regulations (see regulatory category summary).

The President has issued a memorandum to implement his Water Resources Policy Reform Message which directs Federal Agencies to take specific ground-water actions when planning water resources projects and gathering data.

Potentially the most valuable policy foundations for developing a broad, ground-water strategy are NEPA, Section 309 of the Clean Air Act, and Sections 101(a) and 102(a) of the Clean Water Act. The environmental impact statement requirements of NEPA emerge as a unique tool to be utilized by all Federal Agencies in the planning process as it relates to the ground-water resources. NEPA provides EPA, as well as other Federal Agencies, with the opportunity to review, comment on, and, if necessary, recommend modification of Federal Agency actions that affect ground water. However, NEPA is advisory in nature, not enforceable. Currently, the degree of analysis of ground-water considerations varies in environmental assessments and EIS's on a case-by-case basis.

In addition to EPA's EIS review mandate under NEPA, Section 309 of the Clean Air Act directs the Administrator of EPA to review and comment in writing on the environmental impact of any matter relating to EPA statutory authority contained in (1) legislation proposed by any Federal department or Agency (2) Federal construction projects and major Agency actions which significantly affect the environment and (3) proposed regulations published by a Federal department or agency. If the Administrator determines that any such legislation, action, or regulation is unsatisfactory from the standpoint of public health or welfare or environmental quality, he is directed to publish his determination and refer the matter to the Council on Environmental Quality. The 309 authority puts EPA in the unique position of "watchdogging" other Federal agencies activities, as well as its own, concerning how they may affect the ground water resource.

Sections 101(a) and 102(a) of the Clean Water Act promote the objective of restoring and maintaining the integrity of the Nation's waters and call for the development of comprehensive programs for preventing, reducing, or eliminating the pollution of the navigable waters and ground waters. This congressional policy objective could be the impetus behind strengthening or revision of existing programs, or the pursuit of new legislative initiatives.

These existing policies, if expanded or redirected, represent a opportunity for developing and carrying out a ground-water strategy.

Table 1 summarizes this discussion.

PROGRAM DEVELOPMENT

Program development opportunities for ground-water protection are available within the current EPA statutes and authorities, although in many cases they are not fully utilized. Properly structured, these opportunities could provide additional options in implementing a ground-water protection program. Programs included in the category of program development are those relating to planning, management, and implementation, including construction, which generally are grant-related.

Sections 104, 106, 208 and 304 of the Clean Water Act offer specific program potential which could provide the foundation for statewide ground-water protection programs. In two of these programs, 104 and 106, little attention has been given to ground water because of the low priority of this issue. There is, however, a clear opportunity to expand the interpretations and functions within them given sufficient resources. Section 104 funds have not been used for ground water.

Section 304 has been used to make ground-water protection a priority requirement for municipal waste-water projects receiving construction grant funds from EPA. The criteria for best practicable waste treatment (FR 41, No. 29, p. 2160) require that projects are evaluated to protect the ground water for use as a drinking water supply or other appropriate uses.

Section 208 has had a limited ground water focus because of resource and time constraints. It has recently been redirected to encourage States to develop ground-water protection programs. Eight million dollars is being spent on development of ground-water protection controls nationwide. There appears to be an increasing emphasis on "conjunctive" management of surface and ground waters. This program affords one of the key initiatives for ground-water protection.

Sections 4002, 4003, and 4008 of RCRA (non-hazardous waste management) also provide a mechanism to control contamination of the ground water. There is, however, no direct Federal enforcement associated with this program. Refinements can be made in this program, but the language does not appear to provide a basis for an expanded program.

The potential role of Section 1424(e), sole source aquifer designation, is limited according to Federal jurisdiction. It is, by definition, a Federal program designed to provide for protection of the sole or principal sources of drinking water. It is implemented by review of Federal financially assisted projects for potential contamination of underlying ground water resulting in a public health hazard. Procedural regulations for this program are under development. There could still be provisions made in the final regulation to influence other Federal agencies, States and localities with respect to ground water protection through the incorporation of or reference of the EPA ground-water protection strategy currently being developed.

Table 2 summarizes this discussion, identifies relevant grant programs, and identifies in greater detail preliminary potential actions.

REGULATORY

This section includes only those portions of major EPA legislation which are directly enforceable by EPA. Such parts of the Clean Water Act as effluent guidelines and BMP's are included in the Control Technologies and Standards. Emphasis was placed on those regulatory mandates which are implemented by permits.

The strongest EPA regulatory authorities to control pollution of ground water are those regulating underground injection under SDWA; those regulating hazardous waste landfills or other disposal sites under RCRA; and the broad regulatory authority under TSCA Section 6 to regulate chemicals at any step from production to disposal.

Potential regulatory authorities to control pollution of ground water are the discharge permitting authority under Section 402 and the dredge and fill permitting authority under Section 404 of the CWA. The use of FIFRA to control contamination by pesticides and containers is also possible. Use of any specific act may depend on the avenue of contamination to be controlled.

Table 3 summarizes this discussion and provides greater detail on potential actions.

CONTROL TECHNOLOGIES AND STANDARDS

Control technologies include requirements for use of specific types or levels of technology. Standards include uses, criteria (numerical limitations mass concentration), and performance standards. Generally, the technologies and standards identified in the CWA currently are applied to surface water only. An important exception is use of Section 304 criteria for protection of ground water, but only for 201 funded projects. They provide a control concept which may be transferrable to a ground-water management program.

The control technologies identified in the CWA include, for effluent limitations, best practicable control technology (BPT), best conventional technology (BCT), best available technology (BAT), and best management practices (BMP) for nonpoint sources, new source performance standards (NSPS), and innovative and alternative treatment technologies for publicly owned treatment works. In SDWA, the primary ground-water control technology can be found in Section 1421 which relates to the UIC program. RCRA Section 1008 has resulted in guidelines which provide a technical and economic description of the level of performance which can be attained by various solid waste management practices. Both the SDWA and RCRA control technology requirements can provide an initial basis for a ground-water management program.

Historically, standards requirements in the CWA have been applied to surface water. However, several States have existing ground-water standards programs and others are considering using the standards approach. Thus, it is useful to examine the surface water quality standards requirement to determine its potential relevance to any ground-water quality standards program which the EPA Ground Water Protection Strategy might address.

Section 1412 of the SDWA requires the promulgation of primary drinking water standards which establish maximum contaminant levels or treatment technology requirements. These standards apply to water at the tap rather than at the source. RCRA, Section 3004, requires performance standards for owners and operators of hazardous waste management facilities and Section 4004 provides for criteria for classifying sanitary landfills and open dumps. These two sections provide a mechanism for ground-water protection.

Table 4 summarizes this discussion and provides greater detail on potential actions.

INFORMATION DEVELOPMENT AND TRANSFER

Relevant statutory authorities for information development and transfer are divided into three groupings: technical assistance, monitoring, and research and development.

Technical assistance requirements, including collection and dissemination of information, educational programs, and training can be found in all of these statutes.

Each of the statutes also contains monitoring and surveillance requirements. Potential actions identified in regard to monitoring emphasize the need for increased ground-water monitoring, consistency of parameters used by the various programs, and a consolidated monitoring program.

The section on research and development identifies ongoing programs and their related budget, but does not detail a research strategy which is contained in another section.

See Table 5 for a more detailed analysis of information development and transfer requirements.

EMERGENCY POWERS

The type of authority and the normal kind of response for emergencies varies by program area. Authority ranges from that under the proposed Superfund legislation and the existing CWA Section 311 clean-up of spills to the technical advice and assistance offered by RCRA. Most likely the legislation to establish a Superfund would tie together all the disparate pieces now implemented separately by each program office.

TABLE 1

ENVIRONMENTAL PROTECTION AGENCY POLICIES
RELATING TO GROUND WATER PROTECTION

Language	Status of Implementation	Potential Actions
	Clean Water Act - Section 101(a)/102(a)	
Maintain integrity of Nation's waters. Develop comprehensive programs for water pollution control re: navigable waters and ground waters	No implementation for ground water.	Foundation for broad ground water strategy.
	National Environmental Policy Act - Section 101(b) (2), (3), (6)/102(c)	
EIS review of projects to restrict environmental degradation. Enhance renewable resources recycle depletable resources.	Varies case by case.	Administrative directive to the Agency for expanded ground water in review procedures. Establish comprehensive and consistent criteria for ground water review. Use EIS process to tie in ground water strategy with other Agencies.
	Clean Air Act - Section 309	
Review and comment on proposed legislation, regulations and other major Federal actions. Option for CEQ referral.	Implemented through 309 review process in Headquarters/Regions Ground water impact varies case by case.	Administrative directive for expanded ground water focus. Developed comprehensive and consistent criteria for ground water review.

Language	Status of Implementation	Potential Actions
	Executive Policy	
Water Resources Policy Reform Message.	July 12, 1978, implementing memorandum.	Ensure consistency.
	DOI report issued.	
	Resource Conservation and Recovery Act - Section 1003	
Protect health and environment.		
	Toxic Substances Control Act - Section 1	
Prevent unreasonable risk to health and environment.		
	Federal Insecticide, Fungicide, and Rodenticide Act - Section 3 and 6	
Prevent unreasonable risk to health and environment.	Guidelines requiring data on environmental fate of pesticides proposed; final rulemaking expected Summer 1980.	
	Safe Drinking Water Act - Section 1421	
To protect underground sources of drinking water.	Under development.	

TABLE 2

PROGRAM DEVELOPMENT

Language	Status of Implementation	Potential Action
EPA in cooperation with States equips and maintains a water quality surveillance system for the purpose of monitoring the quality of navigable waters and ground waters.	Clean Water Act - Section 104(a)(5) Only surface water monitoring has been implemented. Most of ground water has been done by USGS except R&D/monitoring by Ada Laboratory, at MERL, and at Office of Drinking Water. Appropriation: FY 80 - $3 million FY 81 - $2.5 million	Resume development of ground-water monitoring strategy for Federal/State activities.
Grants to States to prevent, reduce or eliminate pollution.	Section 106 Surface Waters: Funds used at State level for permits, monitoring, training, public participation, program operation, etc. Ground Waters: Little emphasis to date. Program funds traditionally used for surface water programs. Appropriation; FY 80 - $100 million FY 81 - $48.7 million	Authority exists for use of 106 funds in ground water (e.g. NY State NPDES program covers underground discharges), but they have been decreasing over the years. Needs Assessment Advisor Group (NAAG) Should add ground-water functions into their anaylsis as an Agency priority.

TABLE 2

PROGRAM DEVELOPMENT

Language	Status of Implementation	Potential Action
	Clean Water Act 201 202(a)(2)	
Authorizes Administrator to make grants for construction of publicly owned treatment works. Requires consideration of innovative and alternative technologies and 15% cost preference under cost effectiveness guidelines.	Step 1 planning must consider availability of supply, including ground water, for determining size of facility and future growth resulting from the facility.	Ensure in development of Step 1 plans that ground water and surface water impacts are given equal consideration.
Grants are available for privately owned treatment works under certain conditions.	Appropriation: FY 80 - $3.4 million FY 81 - $3.7 million (requests)	
	Clean Water Act 304(a)(2) 304(d)(2)	
Requires Agency to issue information and guidelines to restore and maintain the chemical, physical, and biological integrity of all navigable waters, ground waters, ...	Section 201 projects must protect ground water as a source of drinking water or other appropriate use.	Ensures the above for 201 funded projects.

TABLE 2 (cont'd)

PROGRAM DEVELOPMENT

Language	Status of Implementation	Potential Action
	208 Sections	
Grants to States and areawide agencies to develop water quality management plans to include processes to identify mine-related pollution including underground mine runoff, identify salt water intrusion into fresh waters resulting from ground water extraction, control disposition of residual wastes, control disposal of pollutants in subsurface excavations to protect ground and surface water.	Ground water, originally, was not a National priority, as there was not enough time or resources to address ground water. Increasing emphasis to conjunctive management of surface and ground water. **States are encouraged** to develop statewide strategy for ground-water.	Legal opinions indicate that authority exists for ground-water considerations under 208 as a mechanism for Statewide ground water strategy development and implementation, and to foster development of State Regulatory Programs that UIC and RCRA do not provide for.
		208 is a potential planning tool at local level in areas of "sole source aquifer designation."
	*Appropriation: FY 80 - $37.5 million FY 81 - $34.0 million requested *for all 208 activities	

TABLE 2 (cont'd)

PROGRAM DEVELOPMENT

Language	Status of Implementation	Potential Action
	Resource Conservation and Recovery Act 4002 4003 4008	
State program developed for closing open dumps. State may develop permit programs to implement this action.	Regs. promulgated Sept. 79 Implementation has commenced. Limited actual monitoring will take place. No Federal back-up program. Limited Federal dollars.	Amend statute to assure Federal back-up in the event States fail to complete inventories of non-hazardous wastes.
	Potential ground-water contamination through "small generators" and non-hazardous industrial wastes.	Reevaluate open dump criteria (for improved ground-water quality) for harmful pollutants not covered.
	No financial responsibility on owner/operator for closure or post closure.	
	Appropriation: FY 80 - $10 million FY 81 - $ 8 million (requested)	

TABLE 2 (cont'd)

PROGRAM DEVELOPMENT

Language	Status of Implementation	Potential Action
	4009	
Assistance to rural communities for solid waste management facilities.		
	State/EPA Agreement (SEA) Guidance	
Mechanism to ensure integrated, cost-effective, and coordinated implementation of EPA programs.	All FY 80 agreements signed. FY 81 agreements being negotiated. Increased emphasis on addressing environmental problems.	Continue high agency priority for SEA. Encourage increased emphasis on ground water.

TABLE 3

REGULATORY

Language	Status of Implementation	Potential Action
	Clean Water Act 402	
Control of discharges to navigable waters by NPDES.	Ongoing, but does not reflect interface of surface and ground water. State program must control underground injection from point sources discharge to surface waters.	Rank permit renewal so discharges upstream from drinking water intakes and recharge areas are high priority. Explore extent to which this program can be applied to ground-water contamination from discharges. Look for new ways to use the 208 "consistency" clause to protect ground water.
	404	
Protection of U.S. waters from impacts of dredged and/or fill materials via permit issued by Corps of Engineers, reviewed by EPA.	Applies to protection of ground-water quality especially recharge areas and salt water intrusion. Little or no compliance monitoring due to lack of resources.	Expand CWA definition of "waters of the U.S," to include subsurface waters. Train staff and research regarding ground water/ surface water interaction. Develop permitting strategy that addresses ground water concerns.

TABLE 3 (cont'd)

REGULATORY

Language	Status of Implementation	Potential Action
	Clean Water Act 404c	
The Administrator may prevent disposal at sites specified by Secretary of Army upon determination that discharge will have an unacceptable adverse effect on municipal water supplies.		Utilize this authority to prohibit disposal to navigable waters that recharge aquifers.
	405	
Regulation of sludge disposal methods.	Proposed regulations not yet issued. Section appeared in 1972 Act, and was strengthened in 1977.	Promulgate regulations consistent with ground-water strategy.
	Resource Conservation and Recovery Act 3005	
Control of hazardous waste disposal sites by permit.	To be issued as part of consolidated permits regulatory package.	Rank permitting of sites to minimize ground-water contamination from uncontrolled disposal of hazardous waste.
	3011	
Hazardous Waste Control Grants for States	Appropriation: FY 80 - $18.6 million FY 81 - $30 million	

TABLE 3 (cont'd)

REGULATORY

Language	Status of Implementation	Potential Action
	Safe Drinking Water Act (SDWA) 1421 (UIC)	
Protection by permit for ground water from sub-surface discharges.	Regulation promulgation in process Fifty-seven States and territories eligible for grants.	
	1424(e)	
Protection of sole or principal drinking water source aquifer.	Proposed regulations published Sept. 1976. Final regulations being developed.	Final regulations should contain key elements of "EPA Ground Water Protection Strategy."
	Toxic Substances Control Act (TSCA) 5	
Review of new chemicals prior to manufacture for commerical purposes.	Program operational. Mechanism to control disposal, amount produced and type of use for new chemicals. 90-day review time could inhibit thorough review.	Complete agreement between OPTS and ODW to ensure that ground-water impact of disposal is examined.
	6	
Regulatory control of existing chemicals from manufacture to disposal.	Language general enough to be used any program/media.	Legal/policy definition of "unreasonable risk" - the trigger for any regulation.

REGULATORY

Language	Status of Implementation	Potential Action
		Develop regulatory controls for septic system solvents and other chemicals which pose ground-water problems.
	Federal Insecticide Fungicide and Rodenticide Act (FIFRA) 3,5,18, & 24	
Control of all pesticides by means of registration or other authorization for sale and use only in accordance with practices which do not cause no reasonable adverse environmental effects.	Environmental chemistry data is required prior to registration on which soil transformation, transport and retabolism can be assessed from which to predict ground water effects which may occur through use. Final guidelines expected summer 1980. Production and (limited) use data available from which to assess location and magnitude of ground water "exposure." As re-registration occurs, labels are being changed to read "Bury in safe place away from water supplies."	40,000 products registered.
	19(a)	
Control of pesticides packages or containers and disposal or storage of excess amounts of pesticide.	Guidelines May 1, 1974. Not updated since then. Recommendation: Disposal in accordance with Federal, State, and local pollution control regulations. Well injection only with guidelines from RA. Well injection only if all reasonable alternatives have been explored and found unsatisfactory. Storage where underground water won't be affected.	

TABLE 4

CONTROL TECHNOLOGIES AND STANDARDS

Language	Status of Implementation	Potential Action
	Clean Water Act Section 304 (a)(2)	
	See comments on Table 2 for use of these sections to protect ground water for projects funded under 201.	
	Clean Water Act Section 201(g)(5)	
Grants for construction of treatment works shall not be made unless it has been demonstrated that "innovative and alternative wastewater treatment processes and techniques which provide for the reclaiming and reuse of water...and utilize recycling techniques, land treatment...and the confined disposal of pollutants... have been fully studied...."	Potential for ground-water pollution from land treatment, but also potential for increased recharge. Federal Register, February 11, 1976 defines criteria for evaluating treatment technologies, including land treatment. Primary drinking water standards provide technological basis for protection of drinking water supplies.	Develop criteria for protecting ground water uses other than drinking water. Improve coordination within EPA to ensure criteria are met and program recommendations (e.g. 208, 201, Step 1, Sole Source) are uniform. Review applications for innovative and alternative technologies to ensure ground-water protection, with particular emphasis on Federal Sole Source Aquifers.

TABLE 4 (cont'd)

CONTROL TECHNOLOGIES AND STANDARDS

Language	Status of Implementation	Potential Action
	Clean Water Act Section 204(a)(5)	
Grants for construction of waste treatment works are conditioned on a determination by the Administrator that the size and capacity of such works directly relate to needs. Reserved capacity shall be determined after considering efforts to reduce total flow of sewage and unnecessary water consumption.	Potential vehicle to protect ground-water quantity and indirectly quality. This is now a part of all Step 1 analysis for design of waste treatment facilities.	Give equal consideration to ground and surface water conservation. Disseminate information regarding ground-water quantity/quality relationship.
	Clean Water Act Section 208	
Regulations require development of Best Management Practices (BMP) to address identified nonpoint source pollution problems including ground water quality-related problems.	Initial planning cycle is complete. BMP's that have been developed are supposed to be implemented, tested, revised by 208 management agencies. 208 Funding Policy favors prototype projects to develop managment programs for ground water, including BMP's, which are transferrable to other States.	Develop guidance which addresses BMP's for ground water. Expand and improve existing information exchange programs to transfer state-of-the-art technology in ground-water management.

TABLE 4 (cont'd)

CONTROL TECHNOLOGIES AND STANDARDS

Language	Status of Implementation	Potential Action
	Section 208(e)	
No permit under Section 402 shall be issued for any point source which is in conflict with a 208 plan.		Where point sources discharge to surface water impacts ground water and 208 plan identifies ground-water problem, condition permit to protect ground water.
	Clean Water Act Section 301(b)	
(1)(A) Requires establishment by July 1, 1977 of effluent limitations for point sources other than publicly owned treatment works which shall require application of the best practicable control technology currently available (BPT).	Applied only to discharges to surface water.	Develop similar program for ground water. (Substantial legal problems).
(1)(B) For publicly owned treatment works in existence on July 1, 1977 effluent limitations based on secondary treatment.	Applied only to discharges to surface water.	Develop similar program for ground water. (Substantial legal problems.)

TABLE 4 (cont'd)

CONTROL TECHNOLOGIES AND STANDARDS

Language	Status of Implementation	Potential Action
(1)(C) By July 1, 1977 any more stringent limitation including those necessary to meet water quality standards, treatment standards or schedule of compliance established pursuant to an State law or regulation or required to implement any water quality standard established pursuant to the Clean Water Act.	Applied only to discharges to surface water.	Extend concept to ground water. (Substantial legal problems.)
Section 301(b)		
(2)(A) Establishes requirement for best available technology economically feasible by July 1, 1984 for toxic and	Applied only to discharges to surface water.	Develop similar program for ground water. (Substantial legal problems.)

TABLE 4 (cont'd)

CONTROL TECHNOLOGIES AND STANDARDS

Language	Status of Implementation	Potential Action
	Clean Water Act Section 303	
(a)(3)(A) and (C)(2) Requires States to adopt water quality standards applicable to intrastate waters and submit them to the Administrator for approval.	Has only been applied to surface waters. New policy planned which will make certain pollutants mandatory.	Require encourage States to adopt ground-water quality standards. Seek authorizing legislation if needed. (Substantial legal problems.)
(a)(3), (c) and (d) For States which do not adopt standards within the prescribed timeframe the Administrator shall promulgate standards for those States.	Done selectively. It may only be part of a State's revised standard that is promulgated by EPA. 40 CFR 120 includes standards EPA has promulgated.	Employ similar approach to ground-water quality standards. (Substantial legal problems.)
(c)(2) Revised and new standards shall consist of designated uses of the navigable waters involved and the water quality criteria for such waters based upon such uses.	EPA emphasizing attainability of in place standards. (e.g. for intermittent streams) Emphasizing site specific designations of uses and appropriate criteria to protect them.	Employ similar approach to ground-water quality standards. (Substantial legal problems.)
	Section 303	
(d) Requires States to establish total daily maximum load (TDML) for pollutants for waters for which effluent limitations are not stringent enough to implement water quality standards. (see 303 (d)(1)(A) and (B).	Based on standards.	Apply TDML concept to ground-water aquifers. substantial legal problems.)

TABLE 4 (cont'd)

CONTROL TECHNOLOGIES AND STANDARDS

Language	Status of Implementation	Potential Action
	Clean Water Act Section 304(b)(4)	
Requires identification of the degree of effluent reduction attainable through application of the best conventional pollution control technology (BCT). BCT is largely treatment cost based.	Consideration given to impacts on ground water in determining BCT. Emphasis on good engineering practices such as lining lagoons. RCRA 3004 covers similar situations.	Make consideration of ground-water impacts mandatory.
	Section 304(e)	
Publish regulations for any specific pollutant which EPA is charged with a duty to regulate as a toxic or hazardous pollutant under Section 307(a)(1) or 311 to control plant site runoff, spillage or leaks, sludge or waste disposal and drainage from raw material storage...ancillary to industrial manufacturing or treatment process... and contribute significant amounts of such pollutants to navigable waters.	This is a technology based requirement rather than a performance standard. Same as requirement in RCRA regarding hazardous waste.	Amend or interpret 304(e) to include impacts on ground water during transport to navigable waters. Amend 304(e) to address introduction of these pollutants into ground water.

TABLE 4 (cont'd)

CONTROL TECHNOLOGIES AND STANDARDS

Language	Status of Implementation	Potential Action
	Section 307	
Authorizes EPA to promulgate effluent standards for toxic pollutants. Certain toxic pollutants shall be subject to effluent limitation from application of the best available technology economically achievable for the applicable category or class of point source established in accordance with Sections 301(b)(2)(A) and 304(b)(2) of the Art.	Effluent standard applies to a pollutant nation-wide. See Federal Register, January 13, 1977 for list (e.g. Aldrin, DDT, PCB's etc.).	Amend or interpret authority to extend effluent standard concept to ground water. Apply effluent standard concept to pollutants tied to non-point source activities which may pollute ground water.
	Safe Drinking Water Act Section 1421	
Propose and promulgate regulations for State underground injection controls.	The proposal and promulgation of regulations for the Underground Injection Control program will include detailed control technologies for ensuring mechnical integrity related to injection well construction. Not yet promulgated.	Ensure adequate publicity and and understanding of the regulations. EPA provide technical assistance to States to ensure full implementation of regulations.

TABLE 4 (cont'd)

CONTROL TECHNOLOGIES AND STANDARDS

Language	Status of Implementation	Potential Action
	Resource Conservation And Recovery Act Section 1008	
Publish suggested guidelines providing technical and economic description of level of performance that can be attained by various solid waste management practices including methods and degrees of control to protect public health, protect ground and surface water quality from leachates, etc.	Guidelines have been published.	Ensure coordinated and consistent application at State and local level of solid waste management practices and nonpoint source BMP's.
		Investigate alternative methods of implementation including mandatory guidelines.
	Section 3004	
Promulgate regulations establishing performance standards for owners and operators of hazardous waste management facilities to include location, design and storage.	Regulations proposed. Except to be promulgated in two phases in April and October 1980.	Expand criteria to include additional pollutants giving first emphasis to priority pollutants identified in 1977 Amendments to the CWA.
	Section 4004	
Promulgate regulations containing criteria for classifying sanitary landfills and open dumps.	Promulgated.	

TABLE 5

INFORMATION DEVELOPMENT AND TRANSFER

Clean Water Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 208(i)(1)	
Technical assistance to States in developing and implementing a program for dredged and fill materials.		
	Section 208(j)(1)	
	Agriculture Rural Development & Related Agencies Appropriations Act, FY 80 P.L. 96-108.	
Technical assistance and cost sharing for the Rural Clean Water Program (RCWP).	Appropriation to USDA of $50 million for FY 80, $30 million spent to date. Experimental RCWP Program. 13 projects to date none specifically addressed ground water. EPA approves technological practices. When there may be a ground water problem, practices are required to address it. Request of $20 million in President°s budget for FY 81.	New projects should focus on ground-water problems.
	Section 214	
Public information and education program on recycling and reuse of wastewater (including sludge), the use of land treatment, and methods for the reduction of wastewater volume.		

TABLE 5 (Continued)

TECHNICAL ASSISTANCE

Clean Water Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 304(a)	
Criteria for water quality including kind and extent of effects on health and welfare, including ground water.	Has been published and periodically revised.	Increased emphasis on ground-water.
	Section 304(a)	
Information on factors necessary to restore and maintain chemical, physical and biological integrity of ground water.		
	Section 304(f)	
Publish information including guidelines and proceses, procedures and methods to control pollution from non-point sources. This includes agriculture, mining, constuction, disposal in wells or subsurface excavations, salt water intrusion and changes in flow of surface and ground waters.	Has been published.	Publish additional information reflecting State-of-the-Art in ground-water management, including findings and summaries from 208 ground-water prototype projects.

TABLE 5 (Continued)

INFORMATION DEVELOPMENT AND TRANSFER

Safe Drinking Water Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 1442(A)(2)(a)	
Technical assistance to States and municipalities for development of public water supply system (PWS) supervision program and underground injection control (UIC).	Implementation	
	Section 1442(A)(2)(b)	
Technical assistance to States and publicly owned water systems to assist in responding to and alleviating emergency situations affecting public water systems including sources of water for such systems.	Implementation	Continued ground-water emphasis is necessary.

TABLE 5 (continued)

TECHNICAL ASSISTANCE

Toxic Substances Control Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 10	
Collection and dissemination of data submitted to other Federal departments under TSCA.		

TABLE 5

INFORMATION DEVELOPMENT AND TRANSFER

TECHNICAL ASSISTANCE

Resource Conservation and Recovery Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 2003	
Technical assistance through Resource Conservation and Recovery Panels for Solid Waste Management, Resource Recovery and Conservation.	Experts are assembled in each EPA regional office to provide technical assistance to communities on all aspects of solid waste. Ground water received perhaps 20% of the effort. Use vehicle for other programs--e.g., OWP contributed to the Region IX panel to perform aquifer mapping at an Indian Reservation.	Develop technology transfer process to assure findings are available for other uses.
	Section 4008(d)	
Provide technical assistance to State and local governments for purposes of developing and implementing State plans.	State Guidance provided by Regional Office.	
	Section 5004	
Evaluate commercial feasibility of resource recovery facilities and develop data base for purposes of assisting persons in choosing such a system.	No activity to date. Positions established, but office not yet performed.	Accelerate program development.
	Section 7007	
EPA funds training for all aspects of solid waste management.	Implemented in part through grants to public interest groups. 80 meetings have been held; about 25% of the overall content was devoted to ground water. Also implemented through Peer Match by which the agency pays travel and expenses for experienced officials to consult with other communities facing similar problems.	Develop technology transfer to assure information developed is available to all.

TABLE 5 (continued)

TECHNICAL ASSISTANCE

Resource Conservation and Recovery Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 8003	
Provides for coordination, collection and dissemination of information.	No concerted, programmatic implementation Occurs as normal office function of report writing and publication.	

TABLE 5 (CONTINUED)

INFORMATION DEVELOPMENT AND TRANSFER

MONITORING

Clean Water Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 104(a)(1)	
Shall establish national programs which equip and maintain a surface and ground-water surveillance system.	Established and on going. Major focus on surface water. Primarily oriented toward ambient water quality monitoring and trends rather than compliance. Collected in the Storet data system. Interagency agreement with USGS to do ground-water monitoring.	Increased emphasis on ground-water monitoring.
	Section 106(e)(1)	
Grants to States are contingent on establishing and maintaining a (surface and) ground-water monitoring system capable to supporting the Sec. 305 report.	Coordinated with 104 above. Also entirely devoted to surface water.	Include ground-water monitoring in next grant application round.

TABLE 5 (continued)

MONITORING

Safe Drinking Water Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 1421(b)(1)(C)	
UIC regulations require that monitoring be part of the permit process.	Regulations have been proposed which require both mechanical integrity monitoring and water quality monitoring.	Develop system to integrate monitoring data with data from other programs.

TABLE 5 (continued)

MONITORING

Resource Conservation and Recovery Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 3004	
EPA can require storage, treatment and disposal sites to monitor.	Regulations have been proposed which specify number and location of minimally acceptable monitoring systems. Monitoring objective is regulatory control of individual facilities.	Data generated from 3004 monitoring should be integrated into EPA data collection system.
	Section 4004	
No explicit Federal monitoring authority.	State programs are required to have capability of monitoring facilities.	Data generated under 4004 should be integrated into EPA data collection system.

TABLE 5 (continued)

MONITORING

Toxic Substances Control Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 10	
Shall conduct such monitoring as necessary to carry out the Act.	Only very few incidents have been monitored, even fewer in ground water. Only a few substances, such as septic tank degreasers, will be subject to TSCA ground-water protection.	Develop coordination mechanism to more fully utilize TSCA monitoring capability.

TABLE 5 (continued)

MONITORING

Federal Insecticide, Fungicide and Rodenticide Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 20	
Shall undertake monitoring activities as may be necessary to implement FIFRA and the National Monitoring Pesticide Plan. Shall establish procedures for monitoring environmental and incidental exposure.	Well developed data base on fate and effects of pesticides in air, food, soil, human tissue, etc. Little emphasis on ground water monitoring. Procedures manuals and protocols have been disseminated.	Efforts should be made to include monitoring for presence and potential effects of all pesticides on ground water. Ensure consistency with other programs.

TABLE 5

INFORMATION DEVELOPMENT AND TRANSFER

RESEARCH AND DEVELOPMENT

Resource Conservation and Recovery Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 8001	
Conduct research relating to any adverse health and welfare effects of release of waste constituents; development of new disposal methods, and improvements reducing the adverse effects of disposal. May use pilot plant facilities.	See R&D Strategy.	
	Section 8002	
Conduct detailed study of effects of mining on waste water, including the effects of leachate; study the effects of sludge on water.	Sludge study complete, sent to Congress. Mining waste study commenced. Completion during FY 80.	

TABLE 5 (continued)

RESEARCH AND DEVELOPMENT

Safe Drinking Water

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 1442	
May conduct research related to the provision of safe water supply, including measurement of contaminants and methods of protection from contaminants.	Studies on waste disposal practices, methods of preventing-detecting-dealing with surface spills with underground impacts, impacts of abandoned injection/extraction wells, and impacts of intensive application of pesticides, etc. in recharge areas have been completed. National assessment of impact of surface impoundment on underground sources is nearing completion. Research being conducted on subsurface transport and fate of contaminants.	

TABLE 5 (continued)

RESEARCH AND DEVELOPMENT

Toxic Substances Control Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 10	
Conduct research as necessary for purposes of the Act. Shall establish research programs to develop monitoring techniques.	Principally directed at the assessment and the methodologies for determining fate and effects for classes of chemicals. Ground water may be a small portion of work to date.	

TABLE 5 (Continued)

RESEARCH AND DEVELOPMENT

Toxic Substances Control Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
TSCA Section 8 (a)		
Shall promulgate rules for chemical manufacturers and processors to keep records and submit such reports as may be required.	Proposed rule.	Mechanism available to other programs for data gathering needs.
TSCA Section 8(b)		
Shall compile, maintain and publish an inventory of chemicals manufactured or processed in U.S.	Inventory on computer file. Non-confidential data available for information needs. Confidential data available with proper clearance.	Each office needing data should have at least one person cleared for confidential business information.
TSCA Section 8(c)		
Manufacturers, processors, distributors shall maintain records of all significant adverse reactions to health or the environment from chemical substance or mixture. Shall allow inspection of records by EPA.		
TSCA Section 8(d)		
Shall rule require manufacturers, processors, or distributors of a chemical to submit unpublished health and safety studies for listed chemicals.	Proposed rule.	

TABLE 5 (continued)
RESEARCH AND DEVELOPMENT

Federal Insecticide, Fungicide and Rodenticide Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Anticipatory Research Program (Interdisciplinary)	
Ground-water Research Center for long term ground water research.	Established this year. See R&D Strategy.	
	Energy Research Program	
Energy transport and fate for ground-water and energy monitoring for ground water (development of methods and evaluating systems).		

TABLE 6

EMERGENCY POWERS

Clean Water Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 311	
(2) (a) Promulgate... regulations designating as hazardous substances... elements and compounds which, when discharged in any quantity into or upon the navigable waters...present an imminent and substantial danger to public health or welfare...	National Contingency Plan published 2/10/75. Emergency Response Teams set up in all regions. Oil spills responsibilities shared with Coast Guard. List of 271 substances published, but court ordered injunction in 1978. Therefore reporting not required, and costs not recovered for clean-up of these until 8/29/79 when new regulations were published.	
(2)(B)(ii) Owner or operator of...a vessel...or a facility discharging a hazardous substance determined not removable...shall be liable...for a civil penalty per discharge...based on toxicity, degradability and dispersal characteristics...		
(2)(B)(v) In addition to a penalty... the Administrator may act to mitigate the damage to the public health or welfare caused by such discharge. The cost...shall be deemed a cost incurred under subsection (c)...for the removal of such substance by the U.S. Government.		
(c)(2)...the President shall prepare and publish a National Contingency Plan for removal of oil and hazardous substances... Plan...shall provide for efficient coordinated, effective action to minimize damage from oil and hazardous substance discharges...		

TABLE 6 (cont'd)

EMERGENCY POWERS

Clean Water Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
(f)(2) Owner or operator of discharging facility is liable to the U.S. for actual costs incurred for removal of oil or hazardous substances, nte $50,000,000, except where willful negligence or misconduct is shown. Then...full cost...		
	Section 504	
Provide assistance in emergencies caused by release of any pollutant including but not limited to, those which present, or may reasonably be anticipated to present imminent and substantial danger to the public health or welfare. There is established a contingency fund... Emergency assistance authorized....to prevent, limit or mitigate the emergency, which assistance would not otherwise be provided on a timely basis, and there is an immediate significant risk to health or welfare and the environment. (note: Not limited to water)	No funds have been appropriated. No mechanism for cost recovery.	Superfund will replace.

TABLE 6 (cont'd)

EMERGENCY POWERS

Safe Drinking Water Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 1442(a)(2)(B)	
Provide technical assistance and make grants to States or publicly-owned water systems to assist in responding to and alleviating any emergency situation affecting public water systems, which Administrator determines to present substantial danger to the public health. Grants are limited to: actions necessary for preventing, limiting or mitigating danger to public health in emergency, and would not be taken without emergency assistance...	Not funded. No cost recovery provisions.	
	Section 1431	
Upon receipt of information that a contaminant in, or likely to enter, a public water supply may present an imminent and substantial endangerment to health, and that State/local authorities have not acted to protect health, the Administrator may take such actions as he deems necessary to protect health. Action he may take, but is not limited to, includes issuing orders and commencing civil action, including restraining order or injunction.	No funding. (Used only one time)	

TABLE 6 (cont'd)

EMERGENCY POWERS

Resource Conservation and Recovery Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 7003	
Upon receipt of evidence that handling, storage, treatment, transportation or disposal of any...waste presents an immediate and substantial endangerment to health or the environment, the Administrator may bring suit...to restrain any person,,,or take such other action as may be necessary. Administrator shall provide notice to the affected State.	No cost recovery clause. Program does not take direct, clean-up action, but provides information and technical assistance.	
	Section 3003	
Requirement in regulations for reports and clean-up of spills during transportation.	Not yet promulgated.	

TABLE 6 (cont'd)

EMERGENCY POWERS

Federal Insecticide, Fungicide and Rodenticide Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 6(c)	
Any pesticide previously approved which appears to cause unreasonable adverse effects may have approval revoked through processes of suspension and/or cancellation, with administrative appeal opportunities through adjudicatory hearings.	Several major pesticides found ubiquitously in the environment have had most uses cancelled because of risks posed to health or environment which Administrator deemed to exceed their benefits.	
Suspension is an interim remedy invoked in cases where continued use during such hearings would pose an imminent hazard. It is valid only until the cancellation decision is made. The Administrator may also use Section 6 mechanism to restrict the use of a pesticide to certain trained and certified operators.	Recently a manufacturer voluntarily modified terms of registration to cancel use of aldicarb on potatoes in Long Island after serious ground water contamination was detected. Suspension of DBCP was predicated in part on its presence in well water.	

TABLE 6 (cont'd)

EMERGENCY POWERS

Toxic Substances Control Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 7	
The Administrator may commence a civil action in an appropriate district court... for seizure of an imminently hazardous chemical substance...and/or for relief...against any person who manufactures, processes, distributes in commerce, or uses, or disposes of, an imminent hazardous chemical substance....	Never used. No cost recovery provisions.	

TABLE 6 (cont'd)

EMERGENCY POWERS

Clean Air Act

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Section 303	
...the Administrator upon receipt of evidence that a pollution source or combination of sources...is presenting an imminent and substantial endangerment to the health of persons, and that appropriate State or local authorities have not acted to abate such sources...may bring suit in the appropriate U.S. district court...to immediately restrain any person causing or contributing to the alleged pollution... or take such other action as may be necessary. If not practicable to... commence civil action, the Administrator may issue such orders as may be necessary to protect health...	Used several times in emergency episodes. No cost recovery provisions.	

TABLE 6 (cont'd)

EMERGENCY POWERS

Superfund

LANGUAGE	STATUS OF IMPLEMENTATION	POTENTIAL ACTION
	Several different bills, one freestanding, one amending only Section 504 of Clean Water Act, several amending RCRA, or RCRA and CWA	
Different with different bills. Objective of all is to protect air, surface water and ground water as a resource, in addition to the usual protection of human health and the environment. The fund would pay for abatement of pollution from the source, whether active or abandoned. Several bills would allow remedial action, such as cleanup of ground water. The cost recovery provisions are mostly the suits brought against responsible parties.	Currently under consideration by one Congress.	

APPENDIX VII

A SYNOPSIS OF FEDERAL LAWS IMPACTING GROUND WATER

SYNOPSIS OF FEDERAL LAWS IMPACTING GROUND WATER

This section contains a brief synopsis of those Federal laws which impact ground waters and an analysis of how those laws _might_ be used to implement a ground-water protection strategy. These analyses do not reflect a current policy choice by EPA or a legal interpretation of the law, but are intended only to provide Workshop participants with a picture of those laws which are currently in effect and how they could be used to give further protections to ground waters, if the strategy called for such action. Currently ground-water protection functions are assigned to Federal agencies other than EPA. We have, therefore, included all Federal legislation in this analysis.

U. S. Department of Agriculture (USDA)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Federal Assistance, Resources Conservation and Development Projects 7 U.S.C. 1010-1013	§1010. Land conservation and land utilization--a program of land conservation and land utilization to correct maladjustments in land use, and assist in controlling soil erosion, reforestation, preserving natural resources, protecting fish and wildlife, developing and protecting recreational facilities, mitigating floods, preventing impairment of dams and reservoirs, conserving surface and subsurface moisture, protecting the watersheds of navigable streams, and protecting the public lands, health, safety, and welfare, but not to build industrial parks or establish private industrial or commercial enterprises.	Secretary authorized and directed to develop land utilization program--to assist in conserving surface and subsurface moisture, protect watersheds; health.
	§1010a. Secretary of Agriculture is directed to carry out a land inventory and monitoring program to include, but not be related to, studies and surveys of erosion and sediment damages, flood plain identification and utilization, land use changes and trends, and degradation of the environment resulting from improper use of soil, water, and related resources and issue a land inventory every 20 years.	Includes study of degradation of environment resulting from improper use of soil, water, and related resources.

U. S. Department of Agriculture (USDA)
Agricultural Stabilization and Conservation Service (ASCS)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Water Bank Act 16 U.S.C. 1301-1311	Secretary of Agriculture is authorized and directed to formulate and carry out a continuous program to prevent the serious loss of wetlands, and to preserve, restore, and improve such lands.	Preserve, restore, improve and prevent loss of wetlands and thereby conserve surface waters . . . contribute to improved water quality . . . contribute to improved subsurface moisture . . . promote comprehensive and total water management planning.
	Secretary has authority to enter into agreements with landowners and operators in important migratory waterfowl nesting and breeding areas for the conservation of water on specified farm, ranch, or other wetlands identified in a conservation plan developed in cooperation with Soil and Water Conservation Districts.	Agreements with land owners and operators for conservation of water on specified farm, ranch, or other wetlands identified in a conservation plan could affect ground water.

U. S. Department of Agriculture (USDA)
Soil Conservation Service (SCS)

Fish & Wildlife Conservation at Small Watershed Projects 16 U.S.C. 1001-1009	Erosion, floodwater, and sediment damages in the watersheds of the rivers and streams of the United States, causing loss of life and damage to property, constitute a menace to the national welfare. Cooperate with States and their political subdivisions, soil or water conservation districts, flood prevention or control districts, and other local public agencies to prevent damage and to further conservation, developing utilization and disposal of water, and the conservation and utilization of land.	Further conservation development, utilization and disposal of water.

U. S. Department of Agriculture (USDA)
Soil Conservation Service (SCS)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Resource Conservation & Development Program 7 U.S.C. 1010 et seq.	The Resource Conservation and Development Program was initiated in 1964 to encourage conservation and wise utilization of natural resources in rural areas.	Encourage conservation and wise utilization of natural resources in rural areas. Land treatment--impacts subsurface--but positively in terms of quality and conservation.
Soil & Water Resources Conservation Act of 1977 16 U.S.C. 2001 et seq.	The Act directs the Secretary of Agriculture to conduct periodic appraisals of soil and water conservation programs to ensure that they are responsive to the long-term needs of the Nation. Section 6(a)(5) of the Act directs that an analysis be done of the feasibility and desirability of recycling agricultural, municipal and industrial organic waste materials for use as fertilizer.	Assess overall effects of SCS programs on . . . water quality, water conservation.
Watershed Protection & Flood Prevention Act 16 U.S.C. 1001 et seq.	The Act provides for the prevention of erosion, floodwater, and sediment damages in the watersheds of the rivers and streams of the United States. The Soil Conservation Service (SCS) administers the Act by providing technical and financial assistance to local organizations for planning and installing measures to prevent damage to watersheds.	Technical and financial assistance to local organizations for planning and installing measures to prevent damage to watershed.

U. S. Department of Agriculture (USDA)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Agricultural Credit for Pollution Control 7 U.S.C. 1921-1926, 1932	Loans may be made or insured under this subchapter for (1) acquiring, or enlarging, or improving farms, including land and water development, use and conservation, (2) recreational uses and facilities.	Loans made or insured for land and water development, use, and conservation.
	§1924. Soil and water conservation, recreational facilities and uses, and rural enterprise loans to farmers for the purposes of land and water development use and conservation.	Water and waste facility loans and grants.
	§1926. Water and waste facility loans and grants. Criteria; definitions, limitation on allowable users of Federal funds; inclusion of interest or other income in gross income on sale of insured loan.	
	Provides loans for private business enterprises and pollution abatement and control projects; loan guarantees.	
	U.S. Department of Agriculture (USDA) United States Forest Service (USFS)	
National Forest Management Act 16 U.S.C. 1604(g)(3)(E)(iii)	This section provides for the protection of water resources in the development of forest management plants.	Strong potential role--but limited to areas within jurisdiction of U.S. Forest Service. In being responsible for the entire management of Forest Service lands under the NFMA, the Forest Service has great latitude in protecting ground water.

U.S. Department of Commerce (DOC)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Public Works & Development Act 42 U.S.C. 3131-3133; 3135-3136	Direct and supplementary grants for acquisition or development of facilities; required findings precedent to making of direct grants; supplementary grants to provide matching share funds; sewer and other waste disposal facilities; certification by Administrator of the Environmental Protection Agency regarding adequate treatment prior to discharge into streams.	The Congress is presently considering expanded economic development and public assistance (result and impacts of population growth and public works and development facilities on water quality, uses, development and conservation).
	U. S. Department of Commerce (DOC) Office of Coastal Zone Management (OCZM)	
Coastal Zone Management Act of 1972 16 U.S.C. 1451 et seq.	This provides for financial and technical assistance and Federal guidance to the States and territories to conserve and manage coastal resources. The Office of Coastal Zone Management (OCZM) was created in 1973 to implement the provisions of this Act.	Approved State Coastal Zone Management programs are a strong mechanism for controlling Federal actions within an affected State coast zone. This would include ground-water quantity or quality if it were included within an approved Coastal Zone Management plan. The specific procedure is a "Federal consistency determination" required by §307. Potential for ground water to be included specifically in the scope of the Act. Title I of MPRSA has some limited potential impact on ground-water quality which may result in the pollution of the marine environment.

U. S. Department of Commerce (DOC)
Office of Coastal Zone Management (OCZM)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Marine Protection, Research, & Sanctuaries Act 33 U.S.C. 1401 et seq.	The Ocean Dumping Act establishes a permit system for the regulation of ocean dumping of materials that could degrade the marine environment. The Corps of Engineers has responsibility under Title I for the regulation of the dumping of dredged spoil, through the issuance of permits in accordance with criteria and test procedures developed cooperatively with EPA. Title II of the Act deals with research into the effects of pollution in the marine environment.	
	U.S. Department of Defense (DOD) Army Corps of Engineers (ACOE)	
Appalachian Regional Development Act Amendments of 1975 40 App. U.S.C. 1-2, 203, 205-206, 212	The Secretary of the Army is to prepare a comprehensive plan for the development and efficient use of the water and related resources of the Appalachian region and to recommend measures for the control of floods, the regulation of rivers to enhance their value as sources of water supply for industrial and municipal development, the generation of hydroelectric power, the prevention of water pollution by drainage from mines, the development and enhancement of the recreational potentials of the region, the improvement of rivers for navigation where this would further industrial development at less cost than would the improvement of other modes of transportation, the conservation, and efficient utilization of the land resource, and such other measures as may be found necessary to achieve the objectives of this section.	Could have major potential. Might for example, help to identify sole source or principle aquifers. Also a potential vehicle to inform public of importance of ground water in "water rich" Northeast.

U. S. Department of Defense (DOD)
Army Corps of Engineers (ACOE)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Marine Protection, Research and Sanctuaries Act 33 U.S.C. 1401 et seq.	The Corps of Engineers has responsibility under Title I for the regulation of the dumping of dredged spoil, through the issuance of permits in accordance with criteria and test procedures developed cooperatively with EPA.	
Clean Water Act 33 U.S.C. 1344	Section 404 authorizes the Secretary of the Army to issue permits for the discharge of dredge or fill material into the waters of the United States at specified disposal sites.	404 potential very significant. Wetlands effects as recharge areas.
River & Harbor Act of 1899 33 U.S.C. 401, 403	Section 9 of the River and Harbor Act prohibits the construction of any dam or dike without Congressional consent and approval of the plans by the Chief of Engineers and the Secretary of the Army. Where the navigable portions of the waterbody lie wholly within the limits of a single State, the structure may be built under authority of the legislation of that State, if the location and plans are approved by the Chief of Engineers and the Secretary of the Army. The instrument of authorization is a permit. A Department of the Army permit is required for the discharge of dredged or fill material into waters of the United States associated with bridges and causeways pursuant to Section 404 of the Clean Water Act. Section 10 prohibits the unauthorized obstruction or alteration of any navigable water of the United States. The construction of any structure in or over any navigable water of the United States, the excavation form or depositing.	Impacts usually deal with recharge areas and reservoir and loss of natural recharge areas.

U. S. Department of Energy (DOE)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Nonnuclear Energy Research and Development Act 42 U.S.C. 5901 et seq.	A report by the Department of Energy on compliance with Section 13 of the Nonnuclear Energy Research and Development Act of 1974 indicates that this section provides for a cooperative program between the Department of Energy (DOE) and the Water Resources Council (WRC) to examine the impacts on water resources of emerging energy technologies. Implementation has concentrated primarily on the preparation of basinwide assessments of water resources availability and the impacts of energy development on the environmental, social, and economic resources of the region. There is a growing need for implementation of the provisions for site-specific studies of the impacts of demonstration and commercialization projects. The DOE is required to request site-specific assessments for demonstrating plants having "significant effects," and for commercialization projects.	Portion of the R&D funding provided under this act would be devoted to assessing the ground water impacts of managing energy technologies. Some work is already going on in this area.
Geothermal Loan Guaranty Program under Title II of the Geothermal Energy R&D Act of 1974	The program provides Federal loan guarantees for the acquisition of geothermal resources and development, construction, and operation of geothermal facilities	Geothermal energy has the potential for causing major ground water impacts.

U. S. Department of the Interior (DOI)
Bureau of Land Management (BLM)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Federal Land Policy and Management Act of 1976 P.L. 94-579 (90 Stat. 2743)	Establish public land policies and establish guidelines for their administration; to provide for the management, protection, development, and enhancement of the lands and its resources. Selected sections of the Federal Land Policy and Management Act (FLPMA) provide for the designation and protection of areas of critical environmental concern (ACECs) in the preparation of land-use plans for public lands, and for compliance with applicable State and Federal pollution control laws.	This land use planning could be directed to include protection of ground water; i.e., those recharge areas could have restricted activities.
Outer Continental Shelf Lands Act 43 U.S.C. 1334 and 1346	Provides for conservation of marine life, recreational potential, aesthetic values, as well as reserves of gas and oil on the OCS.	OCS oil/gas and sulpher operations result in development of coastal infrastructure, and almost invariably, secondary economic development. This development changes land configurations, which may decrease the rate of ground water recharging, owing to increased runoff. Increased growth may at the same time put increased demand on ground water. The diminished water in the aquifer can result in salt water intrusion of ground water along the coastal zone. Disposal of toxic drilling and well-treatment fluids on land without proper containment may result in contamination of ground water by leaching of organic chemicals, heavy metals and hydrocarbons.

U. S. Department of the Interior (DOI)
Water and Power Resource Service (WPRS)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Flood Control Act of 1960 74 Stat. 472 (not codified)	Study means of recharging and replenishing Edwards Underground Reservoir.	
The Reclamation Act 32 Stat. 388; 43 U.S.C. 91	This Act provides authority for the Water and Power Resource Administration for the examination and survey for construction and maintenance of irrigation works for the storage, diversion, and development of waters for the reclamation of arid and semi-arid lands in the Western states.	Water service contracts of WPRS can be used to ensure irrigators follow best management practices designed to protect ground-water quality. WPRS requires conservancy district to use BMP as condition to receipt of project water.
	Subsequent authorizations, under individual pieces of legislation, have been made for specific projects or groups of projects. These include, for example, Boulder Canyon Project Act, Colorado River Storage Project of 1956, Spokane Valley Project, and Colorado River Basin Project, Central Arizona Project.	There have been many court cases to determine the "rights of the United States." Generally, the U.S. as the owner of an irrigation project may retain control over and re-use seepage waters from the project.

U. S. Department of the Interior (DOI)
Bureau of Reclamation (BuRec)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Colorado River Basin Salinitv Control 43 U.S.C. 1571-1599	Provides for various water quality improvements, canal or canal lining and salinity control programs, research and other programs downstream and upstream from the Imperial Dam.	

U. S. Department of the Interior (DOI)
Fish and Wildlife Service

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Endangered Species Act 16 U.S.C. 1251 et seq.	The Act established a Federal-State effort to identify, protect, and recover animals and plants which are in danger of extinction. A significant proportion of the ecosystems which the Act seeks to conserve includes or is affected by aquatic, wetland, or marine areas.	Limited to specific geographic areas of habitat--but strong protection against Federal actions which could impact ground water if it is critical to the maintenance of endangered species.
Fish & Wildlife Coordination Act 16 U.S.C. 661-667c	The FWCA ensures that the conservation and enhancement of fish and wildlife resources are considered equally with all other aspects of water resources development projects. The FWCA requires Federal agencies which propose or are authorized to undertake water resource development projects to consult with State and Federal wildlife agencies for the purpose of mitigating and compensating for project-occasioned losses to wildlife resources.	Potentially significant role in ground-water protection--but limited to weak "coordination" requirements which are not enforceable.
	U. S. Department of the Interior (DOI) Heritage Conservation and Recreation Service	
Wild & Scenic Rivers Act 16 U.S.C. 1271 et seq.	The Act established the policy that certain rivers which, with their immediate environments, possess outstanding scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values, will be preserved and protected.	Limited potential role--any real protection authority would be borrowed from CWA's nondegradation protection for "outstanding national resource waters of CWA's101(a) and 40 CFR 35.155(e)." A determination of "no direct and adverse effect" must be provided by the Secretary of Agriculture or Interior for any Federal action affecting water resources of a study category or designated river under Section 7(a), 7(b) of WSRA.

U. S. Department of the Interior (DOI)
Heritage Conservation and Recreation Service

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Land and Water Conservation Fund 16 U.S.C. 4601-4 through 4601-11	Assists in preserving, developing, and assuring accessibility to the quality and quantity of outdoor recreational resources.	Acquisition contributes to preservation for recharge, and restricted use which may protect water quality from degradation.
	U. S. Department of the Interior (DOI) National Park Service and Office of Surface Mining	
National Park System Mining Activity Regulation P.L. 94-429 (90 Stat. 1342)	Regulates mining activity within areas of the National Park System to prevent or minimize damage to the environment and other resource values.	SMCRA has high potential future role in ground water strategy in limited areas. Control of surface activities, such as erosion control, has high potential impact on ground water by affecting runoff to recharging ratios. Surface coal mining may directly impact ground water by hitting water tables, or lowering them for mining needs.
	U.S. Department of the Interior (DOI) Office of Surface Mining	
Surface Mining Control and Reclamation Act 30 U.S.C. 1201 et seq.		Abandoned mine land reclamation will reduce the number of acid mine drainage incidents and other toxic material leaching problems. There is high potential for EPA coordinating with OSM on ground-water quality issues.

U. S. Department of the Interior (DOI)
Office of Surface Mining

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Appalachian Regional Development Act of 1975 40 App. U.S.C. 205	Makes financial contributions to States in the region to seal and fill voids in abandoned coal mines and abandoned oil and gas wells, and to reclaim and rehabilitate lands affected by the strip and surface mining and processing of coal and other minerals.	Control and abatement of mine drainage pollution on abandoned and active mine sites improves quality of water recharging aquifers.
Water Resources Research Act 42 U.S.C. 1961-1961c-8	Conducts research, investigations, experiments and the training of scientists in the fields of water and of resources which affect water.	Contributes to needed manpower supply and knowledge development for ground-water protection.
Saline Water Conservation Water Act of 1971 42 U.S.C. 1959-1959h	Supports research and studies of development of processes and equipment for converting saline water, engineering and technical work for development of desalting processes and plant design concepts for scaled demonstrations, methods for recovery and marketing of by-products as offsets against treatment costs; reduction of impact on environment from discharge of brine into water and economic studies and surveys on water production costs; information concerning relation of desalting to other aspects of comprehensive water resource planning.	
	U.S. Department of the Interior (DOI) U.S. Geological Survey	
Act of March 3, 1879 43 U.S.C. 31 (and subsequent legislation)	Establishes functions of the Geological Survey.and designates USGS as the lead agency for coordinating the activities of all Federal agencies in the acquisition of certain water data from streams, lakes, reservoirs, estuaries and ground water. USGS also provides for cooperative (joint) funding of geological survey scientific and technical investigations with State and local governmental agencies.	Provides data base on amount, quality, location, movement, and changes in U.S. water supply for decisionmaking regarding protection and enhancement of ground-water quality.

Housing and Urban Development (HUD)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Housing and Community Development Act of 1974	Establishes a grant program to undertake a broad range of community development activities including the Community Development Block Grant Program and the Economic Development Administration Program.	Federal grants, loans, guarantees and other financial assistance programs support projects which directly impact the environment. EDA funds physical on land facilities which impact solid waste, water and air pollution. These projects are subject to environmental controls when the nature of the activity constitutes a major Federal action requiring an environmental impact statement under NEPA or the activity must meet specific site, size, or pollution criteria or requirements. The individual Federal actions may be dimensionally small (in size, money or resources) but are pervasive and potentially significant when considered in the aggregate on a regional basis. In terms of financial resources, the aggregate Federal investment exceeds EPA's construction grants program.
National Housing Act Pub. L. 479, 48 Stat. 1246, 12 U.S.C. 1701 et seq.	To ensure adequate and safe housing for the Nation's population.	As with other Federal community and economic development programs projects receiving Federal financial assistance are pervasive in their geographical distribution and should be considered in any national ground-water protection strategy.

Nuclear Regulatory Commission

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Energy Organization Act of 1974	Regulates the development of nuclear power facilities	direct impact
The Uranium Mill Tailings Radiation Control Act of 1978	Mandates the EPA to establish minimum radiation standards for uranium mill tailings and the Nuclear Regulatory Commission (NRC) to implement and enforce the standards	direct impact
Atomic Energy Development and Control	Regulates development, use, and control of atomic energy including the regulation of the disposal into the ocean or sea of by-product, source, or special nuclear waste materials as defined in regulations or orders of the Commission	
	Water Resources Council	
Water Resources Planning Act 42 U.S.C. 1962 et seq.	Provides for the optimum development of the Nation's natural resources through the coordinated planning of water and related land resources, through the establishment of a water resource council and river basin commissions, and by providing financial assistance to the States in order to increase State participation in such planning	Stimulates increased agency effort in the planning and protection of ground-water resources in Federal programs. The Council's Principles and Standards for Planning Water and Related Land Resources set forth general water planning stipulations that increase emphasis on ground water in agency planning. The Manual of Procedures now being developed by the Water Resources Council aids implementation of the Principles and Standards and transmits ground water planning measures to Federal agencies.

All Federal Agencies

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
National Environmental Policy Act 42 U.S.C. 4321 et seq.	The National Environmental Policy Act of 1969 (NEPA) mandates the preparation of an environmental impact statement for major Federal actions significantly affecting the quality of the human environment. As water construction projects as well as other Federal activities commonly have an impact on the ground-water resource, an environmental impact statement is one of the tools that should be used by Federal agencies in the planning process as it relates to the ground-water resource. Agencies subject to Principals and Standards generally are required to meet NEPA responsibilities in conjunction with activities according to Agency Procedures. A Council on Environmental Quality Memorandum dated November 19, 1976, provides guidance and Instructions to Federal agencies for evaluation of the impact of federally assisted projects on ground-water supplies.	
	Environmental Protection Agency (EPA)[1/]	
Clean Water Act Section 101	Restoration, maintenance of chemical, physical biological integrity of Nation's waters; prohibition of discharge of toxics; development and implementation of areawide management planning process; prevention, reduction, elimination of pollutants	
Clean Water Act Section 102	Development of comprehensive program to eliminate pollution	
Clean Water Act Section 104(a)(5)	Establish ground-water surveillance program with States, political subdivisions and other Federal agencies.	

1/ See Appendix VI for more detailed analysis.

Environmental Protection Agency (EPA)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Clean Water Act Section 201	Grants for construction of treatment works to achieve pollution control goals of the Act	
Clean Water Act Section 202(a)(2)	Grants for innovative or alternative projects can be for 85% of cost of construction rather than 75%	
Clean Water Act Section 106	Grants to assist States in administering programs for the prevention, reduction, and elimination of pollution	
Clean Water Act Section 208	Development and implementation of areawide waste treatment management plans	
Clean Water Act Section 209	Level B Basin Plan	
Clean Water Act (State/EPA Agreement Development)	Emphasis of linkages between programs covered under CWA, RCRA and SDWA	
Clean Water Act Section 303	Water quality standards to protect highest possible uses for surface water bodies; includes pollutant level allocations where necessary.	
Clean Water Act Section 303(e)	Planning process for surface water no State may receive NPDES authority without this process	
Clean Water Act Section 304(e)	Best management practices of ancillary activities of point source discharges of section 307(a) toxic pollutants and section 311 hazardous substances	
Clean Water Act Section 304(f)	Guidance on precautions of nonpoint source water pollution	

Environmental Protection Agency (EPA)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Clean Water Act Section 311(j)	Regulations to prevent spills of hazardous substances into surface water from vessels and onshore and offshore facilities	
Clean Water Act Section 311	Cleanup and cost recovery of spills of hazardous substances	
Clean Water Act Section 402(b)(1)(D)	Control well disposal	
Clean Water Act Section 404	Regulatory. Defines requirements for standard setting, permitting, exempting categories, state program delegation, and enforcement	
Clean Water Act Section 405	Guidelines on POTWs sludge disposal	
Clean Water Act SEA	Combining specific statutory requirements to achieve common or complementary environmental goals	
	All Agencies	
Federal Water Policy Initiatives	Issues surrounding ground water	
	Environmental Protection Agency (EPA)	
Clean Water Act (Regs.) Section 35.918-3	Requirements for discharge of effluents (BPWTT)	
Clean Water Act Section 35.925-2	The project must be consistent with any applicable approval water quality management plan	

Environmental Protection Agency (EPA)

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
Clean Water Act Section 35.927-1	Infiltration/inflow analysis to be performed to show possible existence of excessive I/I in the sewer system	
Clean Water Act Appendix A	Cost-effectiveness analysis guidelines requires evaluation of the costs and effects of flow reduction measures	
Clean Water Act Appendix E	Innovative and alternative technology guidelines--identifying and evaluating criteria. Alternative includes aquifer recharge.Innovative methods include those that involve greater recycling and conservation of water resources	
Guidelines for Preparing Facility Plan (May 1975)	Analysis of existing conditions should assess impacts of the various alternatives; including no action, on water quality (incl. ground water)	
Wastewater Treatment Pond (Technical Bulletin)	Discusses protection of ground water from pond seepage	
Evaluation of Land Applications System (Technical Bulletin)	Enviornmental assessment of this alternative must assess impacts on ground water	
Federal Insecticide, Fungicide and Rodenticide Act Sections 6(b) and 6(c)	Regulatory product licensing and use restriction. Protects health and the environment by prohibiting the uses of pesticides shown to cause unreasonable adverse effects.	

Environmental Protection Agency (EPA)
Office of Solid Waste

Act	Coverage of the Act	Potential Future Role in Ground Water Strategy
RCRA Section 3004	Protect health and environment by prescribing minimum acceptable control technologies and facility standards for treatment storage and disposal of hazardous waste.	
RCRA Section 4004	Health and environment, by prescribing those practices in waste disposal which are environmentally acceptable and prohibiting all facilities to determine not to be in compliance.	
RCRA Section 4005	Health and environment--State assessment, by-requiring facilities' Administrator to publish a list of all prohibited facilities.	
SDWA Section 1421	Protection of underground drinking water sources by Underground Injection Control Program (UIC)	
SDWA Section 1422(a)	State/Federal procedures for program adoption	
SDWA Section 1424(a)	Designation of Underground Sources of Drinking Water and Permitting procedures	
SDWA Section 1424(e)	Protection of sole sources of drinking water that are from the ground	
SDWA Section 1431(a)	Provides Administrator authority to take control and actions when public water systems are subject to contamination which may present an imminent and substantial endangerment if State/locals have not taken appropriate action	

APPENDIX VIII

CURRENT STATE GROUND WATER MANAGEMENT PROGRAMS

VIII-6

CURRENT STATE GROUND WATER MANAGEMENT PROGRAMS

A tremendous diversity exists among the States concerning types of laws and regulations addressing ground water protection, levels of sophistication in ground-water management, available funds and resources, for there is diversity in the degree of States' reliance on ground water, its availability and quality, and the uses of ground water. In addition, organizational structures for managing ground water differ from State to State. These factors, along with the lack of any existing State by State analyses of ground water management, make it extremely difficult to present a detailed and accurate picture of the status of State programs without undertaking a substantial amount of original research beyond the time frame of the Ground Water Strategy.

The following information presents a general overview of State ground-water laws and regulations with some specific State examples. Three aspects of State management are addressed: ground-water quality laws, locational controls, and ground-water allocation systems.

GROUND WATER QUALITY LAWS

State agencies involved in ground-water management operate under various and diverse laws. The most common type is the broad environmental law governing pollution of the "waters of the State." Typically, waters of the State are defined as "(a)ll streams, lakes, ponds, marshes, water-courses, waterways, wells, springs, reservoirs, aquifers, irrigation systems, drainage systems, and all other bodies and accumulations of water, surface and underground, natural and artificial, public or private, which are contained within, flow through, or border upon, the State or any portion thereof." (e.g., Minnesota Environmental Protection Law, Ch. 115). The emphasis of these statutes is largely organizational; that is, they are designed to set up departments or agencies that in turn are charged with preparing and enforcing regulations for management and control. A 1978 survey showed that approximately 60% of the States rely on general laws as a basis for ground-water protection. Eleven States rely on individual laws (separate pieces of specific legislation which deal with particular sources of pollution, usually activities, and aspects of ground-water protection) for their ground-water protection activities. These statutes may be in addition to existing environmental laws (e.g., North Carolina) or may be adequate in themselves to provide the requisite protection (e.g., Washington, Idaho). In seven States, general environmental protection laws with specific reference to ground water are used to effect ground-water protection. As of this writing, at least nine States have ground-water quality standards (Virginia, South Carolina, Maryland, Utah, New Mexico, New York, New Jersey, California, and Florida).

Control of Waste Disposal Sites

Solid Waste Disposal - Prevention of ground-water pollution is a major purpose of solid waste disposal regulations. Control of waste disposal sites includes solid waste disposal, individual wastewater systems, and deep well disposal of wastes. Most States have statutes that prohibit disposal of solid waste without a permit from a State or local agency. The statutes typically authorize a State agency to adopt regulations and leave it to that agency to set requirements for the varying conditions that may exist. In some cases the regulations classify sites according to the types of waste that are acceptable (e.g., California). Often the regulations contain special provisions for hazardous waste disposal, usually by defining the category and prohibiting disposal without specific agency approval.

Individual Wastewater Disposal Systems (Septic Tanks) - In contrast to solid waste disposal regulations, prevention of ground-water pollution has not been a major purpose in the regulation of individual wastewater systems, such as septic tanks. These regulations are primarily directed at protecting the health of the septic tank user and his near neighbors. Statutory authority for septic tank control is usually contained in some basic authority of a State agency. Their control is specified in regulations and administration is primarily though local health officers with State supervision. Typically regulations include a requirement that the owner obtain a permit and additional requirements for soil reports and percolation test, minimum lot size, maximum slope, design of system, etc. Some States require that septic tank installers and septic tank pumpers be registered (e.g., Ohio). Some regulations are directed at maintenance and sludge disposal.

Deep Well Disposal - States have enacted statutes directed at disposal of wastes in deep formations where such wastes will be permanently isolated from contact with fresh water resources and from human activity. Some States specifically prohibit the practice. Section 402(b) of the Clean Water Act and Section 1421 of the Safe Drinking Water Act have given the States impetus to address deep well disposal. Generally States only allow deep well disposal if there is no other feasible method.

The terms of State water pollution control laws generally apply to pollution of surface and ground water from oil and gas operations. Provisions in oil and gas laws to prevent water pollution compound those in water pollution control laws providing, in effect, special requirements for oil and gas regulatory activities. For example, all but a few States require installation of surface casing to protect all known aquifers penetrated by oil and gas drilling operations and that this "string" be cemented to the surface. Most States allow use of earthen pits or lagoons for storage of brine produced in connection with oil or gas; however, a number of these States severely restrict their use. Almost all States require that an applicant for a permit to drill an oil and gas well file a performance bond, but most States do not provide funds for the plugging of wells where no responsible person can be located.

Control of Well Construction and Operation

Water Wells - Most States license water well drillers and regulate installation and abandonment of water wells. Regulations may have three functions -- 1) a public health function to assure wells provide a safe drinking water supply, 2) the consumer protection function of ensuring an efficient well, and 3) prevention of pollution of ground water through entry of surface water or polluted ground water into aquifers containing better quality water. Older regulations tend to emphasize the public health function; a number of recent regulations are clearly directed at protection of ground-water resources. Typically, water well statutes require that a permit be obtained by anyone who drills or reopens a well. Regulations are often technically detailed.

Control of Land Spreading of Potential Pollutants

Irrigation Using Waste Water - Spraying of wastewater effluent on land as a disposal method is specifically regulated in only a few States. Most States treat such disposal on a case-by-case basis related to water quality standards, the same as any other discharge. Maryland specifically requires a discharge permit for wastewater effluents disposed of by means of spray or other land irrigation systems. New York, Pennsylvania, Florida and Idaho all address the question in varying degrees of detail. California's Water Reclamation law applies broadly to any use of treated wastewater, whether for land disposal, injection for recharge, or otherwise.

Land Disposal of Wastes - Regulatory provisions governing municipal wastewater treatment and disposal frequently anticipate that sludge will be spread on the land. In most States the basic provision of State law applicable to land spreading of industrial wastes is the prohibition in its water pollution control law against polluting State waters. A State with only this provision generally has the burden of showing that pollution of surface or ground water is resulting from the sludge disposal. Pennsylvania has changed this burden with its "potential pollution" statute which allows the State, where storage, disposal, etc., of materials create a danger of water pollution, or where regulation is necessary to avoid pollution, to require by rule that the activity be conducted under a permit or it may make an order regulating the activity. Various types of special laws may apply to spreading of industrial sludges. Massachusetts Hazardous Waste Regulations require site approval. New York applies its Industrial Waste Scavenger Law and a number of States utilize their solid waste disposal laws.

Control of Storage Areas

Some laws affecting waste disposal refer to storage as distinct from disposal, such as solid waste disposal laws, animal feedlot regulations, deep well disposal regulations, oil and gas drilling laws (surface pits to store oily wastes, water, mud, and brine), and coal strip mine reclamation laws. In most States collections of industrial waste are not subject to any special regulations but are considered simply as sources of pollution which may be maintained only under an NPDES or State permit. A State with only general statutory provisions may find itself in the position of having to prove that ground-water pollution is occurring as a result of a storage activity before it can prohibit or otherwise control the operation. To overcome this burden States have expanded on their control authority in various ways.

Control of Mining and Quarrying

State water pollution control law provisions typically apply to pollution discharges from mining operations. Some States also have provisions specifically directed at mining which control water pollution as an incident to mining activity. These statutes often require a permit. Surface mining reclamation laws commonly contain provisions directed at preventing water pollution as one of several objectives of carrying on strip mine operations with minimal damage to the environment. Surface mining law and regulations also contain provisions requiring certain practices in handling coal, soil and wastes to prevent acid production.

Control of Transportation and Handling of Fluids

Interstate pipelines are under the jurisdiction of the Federal Department of Transportation. Pipelines under State jurisdiction may be controlled by the public utilities regulatory agency or under a specific statute (Delaware requires a permit for construction of any pipeline facility. The possibility of ground-water pollution caused by leaky sewers has been given little attention in regulations. Where a State agency has the authority to approve sewer construction it may as a matter of policy prohibit construction of a sewer line within a specified distance of a well used for water supply. Delaware has an unusual requirement that one must obtain a permit to construct any sewer or pipeline which conveys liquid waste.

Various programs exist for coping with spills. These have not been directed at ground-water protection in the past. Ground water will not necessarily benefit from spill response--for example, if a chemical were held behind a temporary embankment where it can infiltrate into the ground rather than allowed to drain into a river and be diluted.

LOCATIONAL CONTROLS

Under the general heading of locational controls there are several mechanisms which have been utilized to protect ground water quality. Principal among these is zoning.

Zoning - zoning refers to the division of land into districts in which certain uses are permitted, often as of right but sometimes subject to conditions. Zoning power is founded on the power of government to regulate use without compensation based on a showing that the restriction promotes the public health, safety, morals or welfare of the community. It is generally exercised at the local level. In recent years the courts have expanded these tests to cover legitimate environmental concerns. For example, in Hackensack Meadowlands Comm. v. Municipal Landfill Authority, 68 N.J. 451 (1975), New Jersey Supreme Court upheld a law prohibiting the disposal of waste collected outside the State's territorial limits. One justification for the law was the need to protect ecologically sensitive areas from the increasing pressures for sanitary landfill sites. Another example is a Dade County, Florida zoning ordinance limiting development to minimum five acre lots over the Biscayne Aquifer.

In addition to minimum lot size zoning, other zoning techniques include zoning for protection of open space (e.g., flood plain zoning), and subdivision controls and performance-oriented zoning techniques (e.g., planned unit development, matching land use with land capabilities, effluent allocations).

Zoning regulations may contribute to the protection of ground water, even when that is not their primary goal, for example, by limiting the density of residential development or by channeling industrial activities into specified areas.

Designation of Environmentally Sensitive Areas - Zoning is primarily a tool to accommodate development. Critical areas programs focus first on the environmental resource and only secondarily on the type of development that can be accommodated. The function of regulation in these areas is primarily to preserve an ecologically valuable resource, such as a wetland or an aquifer recharge zone. Control of development has also served water quality objectives. Also, critical areas programs often include a data collection and inventory component that could include water quality information. Critical areas approaches are generally State-wide programs and can cover a larger area than local zoning authorities. One example of a critical areas approach is the North Carolina law which provides for designation of "capacity use areas" to protect ground-water quantity and to limit saline intrusion. In New Jersey, the Central Pine Barrens have been designated a critical area for sewerage purposes to limit development in that area.

GROUND WATER ALLOCATION LAW

Because of the obvious relationship between ground-water depletion and ground-water quality it is important to be aware of the provisions of the various allocation doctrines. The law governing ground-water use in the United States generally follows one of the four doctrines discussed below. Obviously there are variations on how these doctrines are applied in different States. The traditional legal classifications of ground water often do not reflect a modern understanding of hydrology. Court decisions based on these classifications add to the complexity of ground-water management.

Absolute Ownership Rule

Under the English or common law rule of absolute ownership the right to use water is based solely on land ownership. A landowner is unrestricted in his use of underlying ground water except that he cannot act maliciously or negligently. He is not liable if his use interferes with that of another. Under the rule of absolute ownership a landowner may waste ground water, use it on lands not overlying the aquifer or sell the water. This rule is essentially the law of capture under which every landowner has the right to pump as much ground water as he can without regard to the rights of others.

Texas, Louisiana, Arkansas, Missouri, Minnesota, Indiana, Ohio, Pennsylvania, Vermont, Massachusetts, Connecticut, Maine, Rhode Island, South Carolina, Georgia, Alabama, Mississippi and, in part, California and New Jersey follow the absolute ownership rule.

Reasonable Use (American) Rule

Under the American rule of reasonable use the right to use ground water is also based on land ownership. It differs from the absolute ownership regarding the amount of ground water that can be used and where it can be used. Under the reasonable rule a landowner is entitled to the reasonable (i.e., not wasteful) use of ground water. Reasonableness is based on the relationship between the ground water use and the use of the land where the well is located. Use on distant lands is unreasonable *per se*. The reasonable use rule is followed in Arizona, Nebraska, Iowa, Illinois, Michigan, Kentucky, Tennessee, Florida, North Carolina, Virginia, Delaware, West Virginia, Maryland, New York, New Hampshire, and Wisconsin.

Correlative Rights

The correlative rights doctrine is basically a judicial extension of the reasonable use rule to resolve ground water disputes among landowners. Under California law the doctrine of correlative rights refers to the relationship between overlying landowners and ground water appropriators.

Prior Appropriation

In most western States the doctrine of prior appropriation has been applied to ground water. The right to use ground water is based on obtaining a State permit which may limit the amount of water withdrawn. Conflicts among ground water users are usually resolved on the basis of priority (first in time is first in right). States following the prior appropriation doctrine include Washington, Oregon, Idaho, Nevada, Montana, Wyoming, Utah, Colorado, New Mexico, North Dakota, South Dakota, Kansas, Alaska, and in part, California and New Jersey.

STATE PROGRAM DESCRIPTIONS

The remainder of this paper presents descriptions of several State ground-water quality standards programs as examples of different State approaches.

NEW MEXICO

The Standards Program

In New Mexico, ground-water standards are numbers that represent the pH range and maximum concentrations of ground-water contaminants which still allow for the present and future use of ground-water resources. New Mexico's ground-water standards are incorporated into its "Regulations for Discharges Onto or Below the Surface of the Ground." The regulations are designed to protect for present and future use as domestic and agricultural water supply all ground water of the State which has an existing concentration of Total Disolved Solids (TDS) of 10,000 mg/l or less. In addition, the Regulations are designed to protect those segments of surface waters which are gaining because of ground-water inflow, for uses designated in the New Mexico Water Quality Standards. The standards apply (with certain exceptions) to all new discharges starting operations post 1977. Older discharges are being brought under the regulation one-by-one.

The standards are administered by the central office of the Environmental Improvement Division (EID) of the Health and Environmental Department which enforces the standards for most activities. The Oil Conservation Division of the Energy and Minerals Department (EMD) regulates oil and gas, CO_2 and geothermal activities; the Coal Surface Mining Bureau of EMD regulates coal mining activities. The responsibilities of the various agencies are defined by statute making the relationships between the agencies formal. The State EPA Agreement (SEA) is not used to coordinate activities between the agencies.

DEGRADATION POLICY

Degradation of the ground water is allowed up to the limit of the ground-water quality standard. If the existing concentration of any contaminant exceeds the standard, due to natural conditions, no degradation beyond the existing concentration is allowed. Contamination predating the standards as a result of man's activities are not specifically required to be improved; however, in the event of an emergency or public nuisance action may be taken.

DEPLETION

New Mexico's ground-water quality standards do not address depletion. The depletion of ground water is the responsibility of the State Engineer of the Water Resources Division.

MONITORING

Activities having potential for ground-water degradation are required to perform self-monitoring. Since standards may not be exceeded at a point of future use, monitoring is done at the present or future point of withdrawal or the property boundary, whichever is closer to the point of discharge. Monitoring requirements such as frequency and points of measurement are established on a case-by-case basis. Reporting requirements are developed in conjunction with the monitoring plan. Violations are determined through the self monitoring and reporting requirements and some independent surveillance performed by the Environmental Improvement Division (EID).

Enforcement begins by informal contact such as phone calls, visits and letters to obtain voluntary compliance. These contacts are "tracked" and a file is built in the event formal enforcement is needed. Formal enforcement has not frequently been required; if necessary, the State's Water Quality Act allows fines and imprisonment.

The EID is in the process of establishing an automated data management system based on the U.S. Geological Survey's OMNIANA system. Currently, information is filed and retrieved manually.

RESOURCES

Total State resources allocated to ground-water protection were not identified. Two people perform areawide monitoring but field follow-up on self monitoring requirements appear to be less than one man-year per year. Resources expended on enforcement are also not specifically identified. The Agency has access to lawyers within the Division including two lawyers who work specifically on water (surface and ground) pollution control problems.

SUMMARY

The EID feels that the standards have been successful for the covered parameters. The State determined that the standards approach is more practical than effluent limitations for ground-water protection because the impact of any effluent discharge depends on the hydrologic-geologic setting thereby making a uniform effluent limitation inappropriate.

VIRGINIA

THE CRITERIA AND STANDARDS PROGRAM

Virginia uses ground-water quality "criteria" and ground-water quality "standards" as tools to manage ground water. State Water Control Board (SWCB) "criteria" represent guidelines to allowable concentrations of specific constituents. State "standards" are health based, allowable concentrations of specific constituents that are not to be exceeded under enforcement penalty. Virginia's ground-water quality standards have been in effect only since 1977. Consequently, some significant policies relating to implementation of the ground-water management program using the quality criteria and standards are still evolving. For example, the point at which measurements are to be taken to determine compliance with state criteria and standards for a particular source of potential contamination has not yet been determined. Virginia's water quality criteria and standards are not uniform statewide. The allowable concentrations of constituents for which criteria exist and four of the standards (pH, NH_3-N, NO_2-N, NO_3-N) vary depending upon which geological province the ground water is located within. This was necessary to take account of the natural water quality differences in the State's four different geological provinces. The criteria and standards are used as a tool to limit the degradation of ground-water quality by specific known contaminants.

DEGRADATION POLICY

In addition to application of the criteria and standards, the State has a policy which specifies that the discharge of contaminants (even those for which a standard does not now exist) can not contravene present or future uses of the ground water.

In those areas where it is found that the ground water quality does not meet the criteria and standards due to natural conditions, it is State policy to prevent further degradation; in those areas where it is found that the ground-water quality does not meet the criteria and standards due to man's activities, the state policy is to attempt to restore the water quality to its natural (pre-pollution) condition. While State law refers to a requirement for non-degradation, what is actually pursued is a policy of reasonable degradation as it is perceived that complete non-degradation is not possible if most of man's presently routine activities are to be allowed to be continued.

DEPLETION

Aquifer depletion and drawdown problems are addressed by use of designated ground-water Management Areas, two of which currently exist within the State. Management Areas can be established by the State Water Control Board acting independently or by local petition to the Board. Criteria for establishing a Management Area include: interference between two or more wells, depletion or potential depletion of a water supply and contamination or potential contamination of ground water as a result of pumping practices. Once a Management Area has been established, major industrial uses within the area are subject to control. At this time, agricultural withdrawals are not subject to regulation.

IMPLEMENTATION

Implementation of the ground-water management program is achieved through both the Virginia Water Control Board staff and the State Health Department. Ongoing activities with ground-water contamination potential such as land fills, waste lagoons and land spreading of wastes are managed by the State Health Department through a permit system. The VWCB manages NPDES permits for point sources, non-discharge waste lagoons and all non-active waste sites.

MONITORING

New sites of potential contamination require the site operator to monitor as a condition of obtaining a permit. Existing sites are being required to monitor as state resources permit. Previously used sites, currently closed, are not subject to monitoring requirements. The State Water Control Board also manages a monitoring network.

All monitoring (including site monitoring by permit holders) is linked to a data management computer having sorting and analytical capability.

RESOURCES

Total State resources allocated to ground water protection activities are difficult to establish the State Water Control Board, however, has a staff of 15 geologists and technicians working in ground water within its central office and the six regional offices. Estimates of State Department of Health resources devoted to ground-water protection are not available at this time.

RESULTS

In regard to the 14 routes of ground-water contamination found to be significant nationally, Virginia's efforts currently are directed primarily at controlling contamination from landfills, waste lagoons, land spreading and NPDES point sources. Virginia is currently developing controls for surface impoundments.

Although the State Water Control Board has the authority to take action against any source of contamination that causes the ground water standards to be exceeded, credible preventive programs for the major routes of potential contamination (excluding the sources above) do not currently exist.

SUMMARY

Ground-water quality standards have been used in Virginia' ground-water management program for only two years. While a firm track record has not yet been established, State Water Control Board personnel feel that the use of ground-water quality standards contribute to managing their ground-water resources.

NEW YORK

BACKGROUND

For many years New York has had a ground-water quality standards program which basically addressed non-organic contaminants. By 1977 it became clear that organic compounds were contaminating ground water in the State, so in 1978, new ground water quality standards which included numerical criteria for organics were put into effect. The water quality standards program is administered through the Department of Environmental Conservation (DEC) and its nine regional offices, which have responsibility for air quality, water quality, and solid waste. The Department of Health (DOH) administers the water supply program and the Department of Transportation (DOT) controls petroleum-related matters.

The Standards Program

Numerical standards are identified for 83 pollutants. The standards for organics are the same as the drinking water standards developed by DOH. There are three classes of ground water in New York: Class GA includes water whose best usage is as a source of potable water; Class GSA waters which are saline waters; and Class GSB which are receiving waters for disposal of wastes. The numerical criteria apply only to Class GA water; however, State policy is that the best usage of ground water in the State is potable water and, therefore, all aquifers in New York are treated as Class GA. Although there is no requirement to clean up existing poor quality ground water, further impairment of quality is not allowed. Thus for example, even if a ground-water aquifer has naturally high arsenic levels, additional arsenic or other pollutants may not be introduced beyond the levels allowed in the standards. The standards apply to all sources of pollution except that effluent standards and/or limitations for discharges to Class GA waters do not apply to:

(1) The discharge of sewage without the admixture of industrial waste when: (i) a disposal system, point source or outlet consists of a subsurface sewage disposal system designed, constructed and maintained in accordance with guidelines and standards satisfactory to the Department;

(ii) monitoring facilities are utilized in accordance with requirements as may be specified by the Department; and (iii) the disposal system is designed to discharge and discharges less than 30,000 gallons per day.

(2) Normally accepted agricultural practice of utilizing chemicals and fertilizers for growing crops for human and animal consumption.

(3) The potential renovative capabilities of a waste management system employing land application techniques and land utilization practices may be permitted for a discharge provided it has been demonstrated to the satisfaction of the Commissioner after his consultation with the New York State Commissioner of Health that: (i) there shall be no actual or potential public health hazard; (ii) applicable water quality standards shall be met in the saturated zone; and (iii) applicable water quality standards shall not be contravened in any adjacent waters of the State.

These exceptions are not to be construed to allow any discharge which would preclude the best usage of Class GA waters.

For organics, no dilution (mixing zone) is allowed. For inorganics there is a two-to-one dilution allowance.

PROGRAM ADMINISTRATION

DEC in Albany is responsible for policy and regulation development. The program is administered on a day-to-day basis by the nine regional DEC offices. The area in New York with the worst ground water problems is Long Island, under the jurisdiction of DEC Region I. That Region delegates responsibilities to Nassau and Suffolk Counties, which have large health departments. DEC and DOH pay these counties fifty percent of their personnel costs; in turn the counties perform monitoring and enforcement activities for the State. The counties report annually to the State and, of course, report emergencies as they arise. DEC, DOH, DOT, USEPA, and local governments have close working relationships and work effectively together to address ground water pollution problems. In New York, the State Pollution Discharge Elimination System (SPDES) administered by DEC includes the delegated NPDES program for surface water and a

State program for ground water. Thus effluent limitations are included in permits for ground-water dischargers.

MONITORING AND ENFORCEMENT

In Region I, violations of ground-water quality standards are usually discovered by the county health departments through their delegated responsibilities to administer the SPDES program and monitor for DOH. This program contains self-monitoring and monthly reporting provisions similar to those in the NPDES program. In addition, the counties have an active program to identify organics-related problems. Nassau and Suffolk Counties both monitor existing water supply and USGS wells. In addition, Suffolk County has two-well rigs and a team of drillers and is in the process of drilling 300 monitoring wells. On Long Island there are three vertical levels of aquifers. The top most aquifer is an extremely porous glacial aquifer, the middle aquifer (the Magothey) is also porous and the bottom aquifer is the Lloyd, which has a limited water supply. Rapid population growth and a lack of central sewage facilities led to nitrate pollution of the glacial aquifer by septic systems. The Magothey is the primary source of public water supply. The Lloyd is used where there has been saline intrusion into the Magothey. Monitoring occurs at all three levels.

DEC, through the county health departments, monitors for pollution control purposes by letting the wells run from the aquifer. DOH monitors the water supply distribution system through the health departments. Region I DEC has requested funds in its budget proposal so it can also perform monitoring. The counties report annually to DEC. In addition, DOT monitors wells in regard to its petroleum responsibilities. A current ground-water problem is resulting from failures of underground gasoline tanks. DEC and DOT are working closely to address this problem.

When the county health departments have informed a polluter of a violation, they will attempt to resolve the problem on an informal basis. If this fails and the correction does not involve a capital cost, the matter will be referred to the DEC Regional Office. If the Regional Office does not succeed, eventually the matter would be referred to the DEC Commissioner who has broad power to issue orders. When a capital expenditure is involved, a compliance schedule would be established and incorporated into the SPDES permit. If the compliance schedule is not met, there would be an administrative hearing and the Commissioner would issue an order. If that order were not complied with, the matter would be referred to the Attorney General for legal action.

Where there is an emergency situation, if it involves petroleum, DOT would become involved through a clean up fund established by the State (maximum $25,000,000). This legislation allows DOT to request the company to stop the accidental spill and clean it up. If the company does not act, DOT can address the problem through use of the clean up funds and then institute legal action through the Attorney-General's Office to obtain reimbursement. No parallel program exists for non-petroleum spills. Thus the emphasis is on preventive action such as county laws requiring testing and rebuilding of underground tanks.

Ground-water depletion is monitored in order to identify problems related to saline intrusion. As central sewage treatment systems are developed, the recharge to ground water is reduced, thus increasing the incidence of salt water intrusion.

SUMMARY

Historically, New York State's water pollution programs have been oriented toward surface water. In recent years there has been reorientation toward ground-water protection. Generally there is still a need for better monitoring and more enforcement personnel.

CALIFORNIA

Like many other states, California's water pollution and water management programs have focused more on surface water than ground water.

MANAGEMENT

Comprehensive ground-water management has not been undertaken in many overdrafted areas of the State. Except in a few areas, ground-water extraction is not managed to the same extent as oil and gas production, timber harvesting, mining, or even surface water diversions. California's ground water is usually available to any pumper, public or private, who wants to extract it, regardless of the impact of extraction on neighboring ground-water pumpers or on the general community. This lack of management has contributed to such ground-water quality problem as seawater intrusion into fresh water aquifers. Steps to combat water quality problems should include ground-water management choices which will vary with the types and extent of ground-water quality degradation, as well as with the availability of water generally.

QUALITY CONTROL PROGRAMS

California's programs to protect ground-water quality, while somewhat fragmented, are fairly comprehensive in scope. A statewide program for water quality control has been established on a regional basis. This program covers ground water as well as surface water. Regional Water Quality Control Boards and the State Water Resources Control Board are required to establish water quality standards for ground water. A permit program for dischargers ensures that these standards are met.

The State Department of Water Resources monitors the numbers and kinds of wells which are drilled statewide and, generally monitors the State's aquifers.

Finally, the State Department of Health Services monitors the waters of the State in general, using the health-based water quality standards to protect the State's aquifers. The State, through the Department of Health Services, has adopted the numerical NIPDWR standards as its own for purposes of ground-water protection of aquifers utilized as a drinking water supply. In addition, MCLs have been separately adopted for several other compounds not included in the NIPDWR. The State policy is that all ground-water resources of drinking water quality should be maintained at that quality. If any drinking water standard is violated by either a current or an intended use of an aquifer, that use must be either modified in order to comply with the standard in question or discontinued. This policy has apparently worked very well, due in no small part to the exceptionally good natural quality of much of the ground water in California. Obviously, cooperation between the various agencies charged with ground-water quality protection is essential. Fortunately, coordination between these agencies, to date, has been very good.

FUTURE

It should be noted that the future of the California ground-water program is uncertain. Firstly, several agricultural areas have discovered a pesticide, DBCP, in their aquifers. It is not known at this time what effect this will have on current ground-water policy. Secondly, the State is currently considering the adoption of MCLs for volatile organic chemicals commonly found in ground water. Such an adoption will almost certainly affect the current users of ground water in California, possibly to the point where treatment prior to use will be necessary on an expanded basis.

APPENDIX IX

OTHER FEDERAL PROGRAMS
WITH
GROUND WATER RELATED-RESPONSIBILITIES

OTHER FEDERAL AGENCIES WITH GROUND WATER RELATED-RESPONSIBILITIES

Several Federal agencies have programs which directly or indirectly impact ground-water management and which are interrelated with EPA programs. These are summarized as follows:

DEPARTMENT OF AGRICULTURE

EPA and USDA have been cooperating in an agricultural nonpoint source strategy. Approximately $100 million in Agricultural Conservation Program (ACP) and Rural Clean Water Program (RCWP) funds, utilizing Soil Conservation Service (SCS) technical resources, are being directed to special projects to implement best management practices (BMPs) to protect water quality. States are using EPA 208 funds to evaluate the projects and to establish State operational agricultural programs.

The detailed soil maps prepared by the SCS are a valuable data base. Over 65 percent of the Nation has been mapped for soils. The maps delineate contrasting soils in two acres or more. For each soil horizon permeability is estimated. Among other data collected are the soil structure (the patterns of cracks and pores), thickness of the horizon, clay content, cement and the pH of the horizon. These maps are often used as a basis for on-lot design or first cut analyses for other waste disposal sites.

The SCS also administers the Rural Abandoned Mine Program (RAMP) which was established by the Surface Mining Control and Reclamation Act of 1977. Up to 20% of the money collected yearly for the Abandoned Mine Reclamation Fund is allotted to the Secretary of Agriculture to control and prevent erosion and sediment damages and to provide conservation and development of soil and water resources of unreclaimed mined lands and lands affected by mining. Where a surface or undergound coal mine operation has significantly affected the hydrological balance, corrective action may be taken. Landowners, including the owner of water rights, residents or tenants may submit a plan for correction action and if approved, the Secretary of Agriculture may enter into a cost-sharing relationship with the landowner providing up to 80% of the funds necessary for reclamation of a land area not to exceed 120 acres.

NUCLEAR REGULATORY COMMISSION

The Nuclear Regulatory Commission (NRC) is responsible for ground-water protection needed as a result of uranium processing at UF6 facilities. There are two types of UF6 conversion facilities: a dry process and a wet process. The wet process generates liquid which must be stored in an on-site lagoon. The lagoons are required to have double liners and a detection system for leakage from the top liner. A second pond must be available to hold liquid from the first pond in the event of a leak. The pond is dried by evaporation and the residue is then buried. Where rainfall is too high to reduce the liquid waste by natural evaporation high energy consumption artificial evaporation is used.

NRC also has responsibility for regulating source and by-product material from uranium recovery operations and associated mill tailings. EPA establishes Best Management Practices and Standards and prepares Environmental Impact Statements for milling operations. The Department of Energy provides funds for the cleanup of inactive milling sites, is conducting research on mill tailing operations and is currently storing high spent radioactive material.

OFFICE OF SURFACE MINING

The Office of Surface Mining (OSM) is the regulatory agency for surface mining activities throughout the United States. States are able to take over their role as a regulatory agency if they submit plans to OSM for a program equal to, or more stringent than, the Federal program. If the State submits no application, or if its plan is deemed inadequate by OSM, the Federal Government will operate a surface mining regulatory program within a State.

The OSM regulations establish requirements which in the course of mining activities maintain or restore to an equivalent state the hydrological balance impacted by mining activities. Before engaging in mining operations, an operator must make a statement to OSM (or the State) on the action's probable hydrologic consequences. Based on these stated consequences the Federal or State government regulatory agency will approve or require modification of the project.

The State regulatory agency, or OSM must also determine what are the likely cumulative hydrological impacts to an area or region which presently has mines or is likely to be mined in the future. This is slightly different in intent than the statement of probable hydrological consequences in that that statement referred largely to the localized vicinity of the mine whereas this discussion is area, or region wide.

The Office of Surface Mining also operates the Abandoned Mine Land Reclamation Program. Funds for the program are collected through fees levied against the operators of active coal mines which then become part of the Abandoned Mine Reclamation Fund. The fund may be used for the protection of public health, safety, general welfare and property from the danger of the adverse effects of coal mining practices; the restoration of land and water resources and the environment previously degraded by adverse effects of coal mining practices; research and demonstration projects relating to the development of surface mining reclamation and water quality control program methods and techniques; protection, repair, replacement, construction or enhancement of public facilities; and the development of publicly owned land adversely affected by coal mining practices.

One-half of the Fund's moneys are to be used for the State Land Tribal programs; 20% of the Fund is used to support the Soil Conservation Service's Rural Abandoned Mine Program; 5% of the Fund which assists small operators of active mines in developing hydrologic studies and water quality analysis.

COAST GUARD

The Oil and Hazardous Substance Liability spill response program (Section 311) is operated under shared Coast Guard and EPA authority. There is a functional geographic division as to which agency responds -- the Coast Guard responds to spills in coastal waters and EPA responds to spills in inland waters (not affected by tidal influence). In addition, the Coast Guard responds to spills which are transportation-related (e.g., pipelines) while EPA responds to nontransportation related spills (e.g. off-shore platforms) regardless of where they are located.

Section 311 itself does not protect ground water. If, however, a spill enters the ground water and subsequently appears in the hydrologically related surface water and if a causal reference between the two events can be made, then there can be a Section 311 response.

OFFICE OF WATER RESEARCH AND TECHNOLOGY

The Office of Water Research and Technology administers a program of water resources research and training, including research on new technology and more effective methods for resolving local, State and nationwide water resources problems; training water scientists, engineers and others through their on-the-job participation in research work; and facilitating water research coordination and the application of research results through dissemination of information about ongoing and completed research. The Office of Water Research and Technology provides funds to a State University Water Resources Center in each State to support research projects. During FY 1980 the Office of Water Research and Technology provides $11 million to the fifty-four centers, including approximately $1 million for research associated with ground water.

Office of Water Research and Technology also operates a Saline Water Research and Development program with a budget of $12 million. This is a national program to advance the technology of desalination and to determine the applicability of desalinized water to water-short areas. The use of brackish ground water as source water for desalination is considered in this program.

Office of Water Research and Technology's other major program is that of Conservation, Reuse and the Water Problems of Urbanizing Areas for which the combined FY 80 budget is $3.6 million. Ground water is an area of interest in the conservation and reuse program.

UNITED STATES GEOLOGICAL SURVEY (USGS)

The USGS is the principal Federal Water data collection agency. The USGS Cooperative Program, the Survey, Investigation and Research program (SIR) and transfers to USGS from other Federal agencies had available in FY 79 about $60-70 million for ground-water related activities. Ground-water quantity and quality phenomena are a sizeable portion of the Geological Survey's water resource research effort (within SIR).

The Federal/State Cooperative Program includes both surface and ground-water investigations. In 1978 the USGS joined in cooperative water resource investigations with 610 State and local agencies. While USGS staff performs most of the work, one-half of the Cooperative Program funding comes from State or local agencies. Major ground-water activities generally deal with aquifer geological characteristics, hydrologic questions associated with the administration of the resource and the delineating of aquifers on maps. General background monitoring is performed to a limited degree in all States but where field circumstances dictate intensive monitoring may occur. Salinity problems have been a major focus of attention within the Cooperative Program but more recently organics and heavy metals have become objects of analysis.

The Cooperative Program is generally conducted within a political subdivision, the Regional Aquifer System Analysis (RASA) Program is conducted on a regional basis, and across State lines where necessary. RASA projects have been selected on the basis of criteria including: 1) the significance of the aquifer system as a present or potential supply of water -- particularly its significance to the national economy or, at least, to the economies of more than one State; 2) the severity of the water problems facing the project area; 3) the potential water needs in the project area -- particularly those connected with energy projection, increasing irrigation, and increasing urban development; and, to a lesser extent, water quality. The RASA budget for FY 1980 is $14 million.

RASA studies currently underway include: California Central Valley, Northern Great Plains, High Plains, Cambro-Ordovician aquifers of the Northern Midwest, carbonated aquifers of the Southeast, alluvial basin aquifers of the Southwest, Atlantic Coastal Plain, Snake Plain, and Central Midwest Carbonate aquifers. Future plans call for initiating three or four new studies each year. The average length of study will be four years. The program is expected to peak in FY 82.

Each study will address water quality as well as hydraulics. The present water-quality distribution throughout the study area will be described and an effort will be make to interpret this distribution in terms of the original flow pattern, the changes in response to development, and the associated geo-chemical processes. The products of these investigations are designed to complement the Survey's continuing program of cooperative ground-water investigations.

Until recently, little has been done to describe where, how, and in what quantities water is used. In recognition of this deficiency, USGS began the National Water Use Data Program by implementing investigations in 16 States during FY 1978. Full implementation is expected in FY 1982.

It should be noted that at rapidly increasing rates USGS efforts are turning to water quality investigations of the subservice. USGS field offices are also increasingly providing input into EPA efforts through responses of the Cooperative Program to requirements which EPA Places on State agencies.

APPENDIX X

GROUND WATER RESEARCH

GROUND WATER RESEARCH STRATEGY

The Nation has entered a period of increasing interest in the protection of the quality of its ground water. A recent prolonged drought in certain of the Western States resulted in the agricultural community turning to the utilization of ground water to prevent an economic catastrophe. At about the same time, drinking water in the North Atlantic States was found to contain traces of organic compounds believed to be carcinogens. Concurrently, ground-water contamination from waste disposal sites was reported from all parts of the country.

While regulations were being prepared in response to the Safe Drinking Water Act, the Resource Conservation and Recovery Act and the Toxic Substances Control Act came into being, placing additional burdens on the Agency in this area. In construction grants, conventional waste treatment systems could only be justified if it could be demonstrated that they were superior to land application systems. For the first time EPA began to seriously consider ground-water resources in planning under Section 208 of the Clean Water Act.

The preparation of regulations and their support documents, the designation of sole source aquifers, enforcement actions, area-wide planning, and the protection of drinking water, as well as water for other uses, created a new need for technical information by all facets of the Agency. To a considerable extent this information did not exist, and it was found that much of the technical information applicable to air and surface water was not transferable to the subsurface environment. The aim of this paper is to identify those information gaps and to suggest ways to fill them.

A meaningful research strategy necessarily requires that the type of technical information needed by the user community be identified and placed into discrete categories. The difference between that information required and that known for each category constitutes a listing of research needs. These needs, when expressed in terms of completion time, dictate resources requirements for their completion and constitute a research plan.

There are areas which are not included within this research section, yet they are salient parts of any effort to protect underground water and will be addressed elsewhere. For example, a monitoring system may be required to establish background water quality, define areas of existing contamination, and characterize existing sources of contamination.

In addition, existing legal and institutional mechanisms and constraints for ground-water protection must be determined before any program can be fully effectual.

There are two other important areas not included in this research portion of the ground-water protection strategy since they have been arbitrarily defined out of the scope of this effort because of the desire to concentrate on areas not addressed in other efforts such as surface water or drinking water protection. These are health effects and water treatment, particularly with respect to organic contaminants.

RESEARCH CATEGORIES

The following research categories were first developed in the Fall of 1976 on the advice of an advisory group representing various EPA Offices, universities, the USGS, State agencies, consultants, and other interested associations. Subsequently, they have been refined based on the views of the Agency's Science Advisory Board, the National Drinking Water Advisory Council, the Subcommittee on the Environment and Atmosphere of the House Committee on Science and Technology, and various continuing committees within EPA. The research categories are:

Methods Development
Contaminant Transport and Fate
Subsurface Characterization
Specific Sources of Contamination
Aquifer Rehabilitation
Information Transfer
Technical Assistance

Methods development refers to any technology used to conduct ground-water investigations. This can be as basic as the location, drilling, and completion of various types of monitoring wells or as complex as the identification of sources of ground-water contamination.

Contaminant transport and fate studies refer to the development of quantitative information concerning contaminant movement and the processes of immobilization and transformation in both the saturated and unsaturated zones. Listed in increasing orders of complexity, the classes of contaminants for which this information is required are: salts, nutrients (primarily nitrogen and phosphorus), metals, organics, and bacteria and viruses.

Specific sources of contamination constitute the primary cause for concern among most regulatory agencies and others whose concern is the protection of ground-water quality. It is important to note that the previous research categories are necessarily precursors to investigations of specific sources. The following nineteen sources of ground-water contamination are listed in priority according to their pollution potential by volume. It is a useful, even if imperfect, list which suggests that the top few sources are more pervasive than the last; it does not suggest that any one source is innately of more concern than the one which immediately follows. For example, subsurface disposal systems are considered a major problem because of their numbers and distribution, yet in another sense industrial surface impoundments, though less numerous, often contain a more hazardous waste. The magnitude of the health risk posed by an individual source is a function of toxicity, volume, geological siting and proximity to use.

1. Subsurface Disposal Systems
2. Petroleum Exploration and Development
3. Landfills and Dumps
4. Agricultural Practices
5. Surface Impoundments
6. Natural Leaching
7. Land Application of Wastes
8. Artificial Recharge
9. Water Well Construction
10. Ground Water Development
11. Waste Piles and Stock Piles
12. Mining
13. Storage Tanks and Transmission Lines
14. Accidental Spills
15. Drainage Wells and Sumps
16. Surface Water
17. Highway Salting
18. Industrial Disposal Wells
19. Air Pollution

Aquifer rehabilitation generally refers to the restoration of water quality in an aquifer after it has become contaminated and the waste source isolated or removed. This is often ineffectual with present technology and conceptually is a costly undertaking both with respect to money and time--this emphasizes the need to concentrate on aquifer protection rather than restoration. Unfortunately, there are many cases where the subsurface has been contaminated by hazardous waste thereby threatening drinking water and restoration is imperative regardless of cost. Thus the need for a research effort into rehabilitation techniques.

Information transfer refers to the conversion of technical information obtained through research to some media available to the user of that information. The capacity to react to instances of ground-water pollution, as well as the ability to predict changes in ground-water quality is hampered, to a large extent, by a lack of information and training.

Technical assistance is an extension of information transfer directly by research personnel to other parts of the Agency, State and local personnel, and others requiring such assistance.

TECHNICAL INFORMATION REQUIRED

Methods development is basic to all aspects of ground-water quality protection ranging from the development of sound aquifer management plans to enforcement activities. For example, both simple and complex ground-water models are required to understand the subsurface environment and make predictions on the impacts of development as a water supply and the consequences of waste disposal and treatment practices on ground-water quality.

Methods for characterizing aquifers in terms of their potential as a water supply and methods for evaluating waste disposal sites are integral parts of basin management plans.

Monitoring techniques and the use of tracers play important roles in all aspects of ground-water investigations. For example, they serve to establish background quality and quantity conditions, determine when waste disposal facilities have failed, show fault in contamination cases, and provide information for research activities.

Unfortunately, many cases of ground-water contamination have been reported in all parts of the country and undoubtedly others will be found in future years. There is an increasing need for technical information which will allow contaminated aquifers to be restored and will isolate sources of contamination from aquifers.

Finally, there is a need for better and more unified data storage and retrieval systems which account for horizontal and vertical dimensions as well as time.

Information on contaminant transport and fate is needed in order to evaluate the effects of human activities on changes in ground-water quality. Basically, the type of information required is the characterization of movement of classes of contaminants through classes of geological materials. This includes an understanding of sorption, chemical and biological degradation, volatilization, and fixation. As mentioned earlier, information is required for salts, nitrogen and phosphorus, metals, organics, and bacteria and viruses in geological material ranging from sands and gravels to clays.

Subsurface characterization information is needed in order to evaluate the subsurface as a receptor of contaminants and improve our ability to identify and predict changes which will occur as a result of residence in the subsurface. Characterization information will be in terms of the physical, chemical, and biological properties of the subsurface environment. The need for technical information varies as a function of the proposed regulatory option. For example, a no-discharge option would preclude the use of the subsurface as a receptor of contaminants resulting in no need for this type of technical information. Conversely, options involving ground-water standards, aquifer management, or the establishment of protection zones will require thorough information on subsurface characterization.

The technical information required for specific sources of contamination is dependent upon the type of control option selected. For most options, however, this information consists of: (1) the number and location of each source; (2) a characterization of contaminants entering and leaving the source; (3) the availability, feasibility, and effectiveness of control or management measures, incuding design and construction, operation and maintenance, closure, and on-site treatment of effluents; and (4) as mentioned earlier, methods for monitoring the effectiveness of controls. Although zero discharge or total containment is not practical for all of the identified waste sources, it is feasible for some. In this case, monitoring methodology is needed to assure that containment is effective.

Technical needs for aquifer rehabilitation are of two parts. One is the actual rehabilitation of the contaminated saturated and unsaturated zone and the other is the removal or isolation of the source of contamination. Basic to these needs is information for determining the source of aquifer contamination and a decision tree for whether remedial action is necessary or feasible and the extent of rehabilitation which is required. Since some contaminants pose more of a potential threat to public safety and to the subsurface environment than others, economic, social, and engineering information is required to assist in decisions between rehabilitation and the development of alternative water supplies.

Information transfer needs are as varied in technical content as the audience to which they are to be directed. It can be estimated that persons adequately trained to plan and carry out ground-water quality investigations number only in the hundreds in this country, while those required at all levels of government and in the private sector number in the thousands. It is clear that increasing this technical base is paramount to all aspects of ground-water protection and use.

Reports are needed, based on existing knowledge, concerning the proper methods for conducting field investigations including monitoring well construction and siting, proper sample collection, and the fundamentals of contaminant transport and fate both in the unsaturated and saturated zones.

This material can take several forms including state-of-knowledge documents, techniques manuals, general educational films, video tapes, and information centers.

Technical assistance is in a very real sense an extension of information transfer by research personnel to other parts of the Agency, State and local personnel, and others requiring such assistance. Technical assistance is a personnel intensive effort usually involving those who are recognized as experts in their field. Therefore, inordinate use of their time for this purpose is particularly costly in terms of established research goals. Technical assistance can be provided in the form of drafting regulations and support documents; planning for specific ground-water investigations; special state-of-knowledge reports; special analytical services; training for Regional, State, and local personnel; providing advice and expert testimony in enforcement actions; and other consultation as requested.

EXISTING KNOWLEDGE AND ONGOING RESEARCH

The amount of research directed toward ground water has increased dramatically in recent years even in countries outside the United States who have traditionally been active in this area. Worldwide, it appears that this increased emphasis stems from water shortages, surface degradation, and reliance on underground water resources.

Because of increased efforts in ground-water research, much of the technical information to come from that research will not appear in technical journals within the next few years. It is important for the development of this research plan to estimate the general direction of ongoing research to help outline information gaps in future years.

Methods development as related to ground-water quality protection differs from that of surface water technology primarily in overcoming problems of inaccessibility. Inaccessibility causes the unpredictability, difficulty, and expense of obtaining representative data and limits the options available for monitoring water quality, for developing technology for predicting pollutant movement in the subsurface, and for reclamation of contamined ground water.

Some work has been done on a number of geophysical techniques to indicate changes in ground-water quality but these techniques have not progressed to the point of replacing expensive monitoring wells except in ideal conditions. Even though a great deal of work has been accomplished in methods for installing monitoring wells, serious problems remain with alterations of the physical, chemical, and biological properties of the subsurface.

Coring techniques have been developed for collecting samples of anaerobic bacteria but these are restricted to rather shallow depths and limited to a few types of geological material.

Methods are available to sample water wells for most inorganic parameters. Technology is available for collecting uncontaminated, representative samples for trace organic and biological parameters in relatively shallow subsurface environments.

Although there has been some work in the development of indicator parameters for classes of contaminants, this remains one of the major deficiencies in many aspects of ground-water investigations.

Mathematical models have been used extensively in ground-water investigations primarily in flow analyses and mass transport of conservative pollutants. Only about 20 percent of the world's existing models are generally usable for one reason or another, principally because of documentation.

Active work in the United States ranges from the development of tracer techniques to well completion and monitoring methods. Other work deals with methods to predict the effect on ground water of certain mining activities and technology for sampling in the unsaturated zone.

On an international basis, ground-water research also appears to be shifting to considerations of trace organics both in modeling and transport kinetics. Poland is attempting to isolate sources of contamination using resins, France is developing seismic techniques applicable to shallow geology, and the United Kingdom and Israel are working on methods to isolate viruses.

Most transport and fate studies have traditionally been associated with inorganic contaminants and, to a lesser extent, metals. A great deal of information exists in these areas even if imperfect in minor ways. There has also been a great deal of work concerned with the transport and fate of nitrogen and phosphorus compounds in the subsurface. Of these areas, knowledge in the movement of metals and nitrogen compounds is the most lacking.

Knowledge concerning the transport and fate of inorganic contaminants in both the saturated and unsaturated zones is particularly fragmentary. Until very recently, a false sense of security concerning this problem existed among most regulatory and research groups because of the inflated conception of the attenuating capacity of the soil mantle for organic compounds. Current information permits only generalized conclusions concerning the movement of a few organic compounds. In the subsurface environments, mathematical expressions capable of providing a first generation predictive ability for a selected group of organics in some subsurface environments are under development.

Considerable attention has been devoted to the transport and fate of pathogenic microorganisms in the subsurface because of the long-recognized health implications associated with this class of contaminants. Nevertheless, knowledge in this area remains less than definitive, particularly in the case of viruses.

Active work in the United States is concerned with the transport and fate of nutrients and metals while that associated with organics remains limited. Exceptions to this lie with the USGS and work supported by EPA.

Most international transport studies are concerned with metals and conservative pollutants. Sweden, the Netherlands, Switzerland, and to some extent the United Kingdom are doing excellent work in organics transport.

Subsurface characterization studies of the earth's crust below the upper soil mantle have not been concerned extensively with the nature of this environment as a receptor of pollutants. Through the efforts of researchers in such fields as agriculture, petroleum engineering, geology, geochemistry, and hydrology, we know a great deal about various aspects of the composition and structure of the earth's crust and how water moves through it. Unfortunately, available information is inadequate to describe what occurs when pollutants are introduced into subsurface regions since the need for such information has been recognized only recently.

Although little, if any, work of this nature is under way in the United States, Australia, Germany, Poland, and the Netherlands have some activity with the upper soils in land application projects. There is some evidence that this type of work is under way in the USSR but details are difficult to obtain.

Information on specific sources of contamination is abundant in the literature. The amount of information precludes extensive discussion in this document; however, certain generalities can be made. For example, even though a great deal of information exists concerning septic tanks, this is mostly concerned with design and the contribution to ground water of such contaminants as coliform bacteria, nitrogen, phosphorus, and total dissolved solids. Little is given on viruses, trace organics, nitrogen losses to the atmosphere, or allowable septic tank densities.

Most work associated with the development and production of oil and gas deals with salt water while little is provided about drilling fluids, chemicals used in treating wells, corrosion inhibitors, and other drilling practices.

Although leachates from purely municipal landfills and dumps have generally been characterized, the presence of industrial wastes in municipal dumps however, makes such a characterization very difficult. In most cases, information on the location of these sites is nonexistent.

There have been a number of investigations relating to the leakage of surface impoundments even though the treatment of trace organics is somewhat limited. The current EPA Surface Impoundment Assessment, which is nearing completion, will give a much better idea of the potential impact of this method of waste disposal on ground water.

Specific sources of contamination are being studied constantly throughout the world. These studies predominantly deal with waste dumps, agriculture, ground-water recharge, land application of wastes, and well construction. Belgium has worked with industrial spills of hydrocarbons, and New Zealand is concerned with agriculture, septic tanks, and land application projects. The USSR has done considerable work associated with mining.

Aquifer rehabilitation studies conducted to date have been directed toward prevention, including causes and occurrences, procedure for control, and methods for monitoring. Case histories of 116 ground-water contamination incidents reveal that remedial action is usually complex, time-consuming, and expensive.

About the only large scale work in this area is on-going in Switzerland and Germany. The Swiss have established emergency procedures for pumping and treating contaminated ground water in spill areas. A university in Germany has established a research and demonstration project for pumping, treating, and recharging contamined ground water.

Information transfer is an area of shortcoming for the scientific community in general and ground-water scientists in particular. There is probably no resource as heavily used and yet so commonly misunderstood by its users, managers, and regulators as ground water. This is evident in the survival and even proliferation of folklore regarding the "water witch" even among otherwise sophisticated journalists.

The most common ground-water information medium in the past has been, and continues to be, technical reports or publications in technical journals. Ground water science is truly a multidisciplinary effort. Articles on ground-water quality may be found in journals of geology, hydrology, engineering, chemistry, agriculture, and microbiology, as well as others. The U. S. Geological Survey has for many years published ground-water reports, primarily related to water quality and availability. Quality aspects were usually, though not always, limited to the more conservative constituents such as chlorides or sulphates, or other natural pollutants.

Since 1967, EPA and its predecessor agencies have published a limited number of reports on ground-water research. Also, many of the State water agencies publish reports on the status of their ground-water resources.

Despite its widespread use, there are perhaps only three national periodicals devoted exclusively to ground water. The National Water Well Association publishes the Water Well Journal monthly and the Ground Water Journal bimonthly. The Water Well Journal is directed primarily at the water well driller while the Ground Water Journal is devoted to the more technical and scientific aspects of ground-water management, including quality. The Water Information Center of Syosset, New York, publishes the monthly Ground Water Newsletter, a synopsis of current events related to ground-water management.

The second most common form of formal ground-water information transfer is technical meetings. An early national meeting devoted exclusively to diverse ground-water quality problems was a 1961 symposium entitled "Ground Water Contamination," sponsored by the U. S. Public Health Service and held at Cincinnati, Ohio. A number of national technical meetings, most notably those sponsored by the American Geophysical Union, have devoted a portion of their programs to ground-water related issues. Since 1971, EPA and the National Water Well Association have conducted four national Ground Water Quality Symposia and published proceedings on each.

Because of the recent great interest in ground water and ground-water management, in 1978 EPA established a Clearinghouse for Ground-Water Models at Holcomb Research Institute. The purpose of the Clearinghouse is to make existing ground-water models more accessible to the user and improve communication between management and those who provide technical services employing models.

RESEARCH NEEDS

Recent and ongoing ground-water research indicates a response to new technical information needs rather than a departure from traditional ground-water investigations. In addition to the increased emphasis in ground-water protection, these information needs result from the fairly recent and widespread discovery of trace organic compounds in the subsurface environment, regulations requiring better monitoring methods, and the desire for more accurate information concerning land use practices and their effect on this water resource.

The following areas of research are suggested to address existing technical information deficiencies. They are necessarily categorical in extent rather than a detailed listing of specific projects. In some instances the suggested work is an extension or modification of existing technology while in others the work is entirely original.

In methods development a series of basic tools are identified as deficiencies in ground-water investigation and management projects. For example, additional modeling capabilities are required to address economic and management problems and those in mass transport, particularly of organic and biological contaminants.

Aquifer characteristics require definition beyond the traditional hydrogeologic parameters. Improved determination of aquifer boundaries and recharge zones are required along with the ability for geophysical and hydrogeologic mapping for land use evaluations. The improvement or adaptation of existing logging technology is suggested.

Traditional ground-water monitoring technology falls far short of current and future needs. A great deal of improvement is required in the manner of drilling, completing, and sampling monitoring wells for specific purposes. Research is needed on methods for monitoring leakage in the unsaturated zone and in general the effects of waste disposal practices on ground water. In-situ monitoring, remote sensing, and the proper use of tracers are all areas of required development or improvement.

Of paramount importance is the improvement and perhaps standardization of methods for storage and retrival of ground-water data.

A great deal of work is required in contaminant transport and fate particularly in organic and biological contaminants. Some work remains with respect to metals particularly in changing oxidation-reduction phases. With all of the work that has been accomplished with respect to nitrogen, additional and perhaps extensive efforts remain to characterize the transport and transformation of the compounds of this element in the subsurface environment. Extensive research will be required to develop classes of contaminants and selecting an indicator for each of these classes in developing transport and transformation information. This is particularly true with respect to organic, bacteria and viruses, and to a lesser extent, metals. An important goal of this area of research is the development of indicators for monitoring.

Since almost no work is completed or underway in subsurface characterization, all needs must be addressed by new research. This is an extremely important area about which little is known but which ultimately will lead to criteria for work disposal site selections. Initial efforts should be directed toward defining the nature of the subsurfaces environment in terms of its innate physical, chemical, and biological characteristics and developing a unified theory correlating these findings with contaminant transport. Even before this is attempted considerable work will be required which could fall under the methods development category and would be applicable to monitoring. For example, a method must be developed to directly or indirectly measure the redox potential with depth.

Research needs on specific sources of contamination are too diverse and lengthly for a complete discussion here. It should be restated that research in methods development, transport and fate, and subsurface characterization, are paramount in addressing specific sources correctly. By way of example, research concerning septic tanks should be aimed at developing density criteria. The effluent from these systems should be characterized to determine the controlling parameter in terms of density. In the past nitrate has been used for this purpose in lieu of organic or perhaps viral contaminants due to the lack of of information on content or the transport characteristics of those parameters. Once this information is obtained, density becomes a function of subsurface characteristics.

Examples of research in petroleum exploration and development would at least initially center around salt water disposal practices. Definitive ways to determine the extent of ground-water contamination from this source are lacking.

Additional research is needed to determine the permeability or effectiveness of liners to the constituents of leachates in landfills or wastes stored in lagoons.

Like septic tanks, additional work is required to evaluate current design standards for land application systems in terms of the organic and biological content of the waste with consideration of the subsurface characterization at a specific site. The same considerations hold true with land farming or land applications of all residuals from municipal and industrial waste treatment and mining operations.

Research in the area of aquifer rehabilitation will be both innovative and an extensive or improvement of existing technology. A very extensive area of research is required in the physical or hydraulic isolation of waste sources and the treatment of contaminated ground water either insitu or upon removal.

Information transfer and technical assistance are in a sense related with respect to an Agency strategy on ground-water protection. Systems must be developed for distributing existing and future technical information to the user community in a form applicable to their needs. Extensive efforts must be dedicated to increasing the number of specialists in all facets of the ground-water industry through training and other information exchange media. Better techniques must be developed for exchanging technical information with other countries. An information center could serve as a way to make information readily accessible to all parts of the Agency, other Federal Agencies, consultants, and particularly the States. A system to report incidences of ground-water contamination should also be established. Finally, a system of providing limited technical assistance to the Agency and the States in specific areas is needed.

APPENDIX XI

ACRONYM LIST

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ACEC	Areas of Critical Environmental Concern
ACOE	U.S. Army Corp of Engineers
ACP	Agriculture Control Program
BAT	Best Available Technology (Water Quality)
BCT	Best Conventional Technology
BLM	Bureau of Land Management
BMP	Best Management Practice (Water Quality)
BPT	Best Practicable Control Technology
CAA	Clean Air Act
CFR	Code of Federal Regulation
CHEMTREC	The Chemical Transportation Emergency Center
CWA	Clean Water Act; also known as the Federal Water Pollution Control Act (FWPCA)
CZMA	Coastal Zone Management Act
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOI	Department of Interior
DOT	Department of Transportation
EDA	Economic Development Administration
EDC	1,2-dichloroethane
EIS	Environmental Impact Statement

FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FLPMA	Federal Land Policy and Management Act
FMAP	Financial Management Assistance Project
FWCA	Fish & Wildlife Coordination Act
FY	Fiscal Year
HUD	Housing and Urban Development
MCL	Maximum Contaminant Level (Drinking Water)
MERL	Municipal Environmental Research Laboratory
MGD	Millions of Gallons per Day
MOU	Memorandum of Understanding
MPRSA	Marine Protection Research and Sanctuaries Act
NAAG	Needs Assessment Advisory Group
NCI	National Cancer Institute
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act
NIPDWR	National Interim Primary Drinking Water Regulations
NPDES	National Pollutant Discharge Elimination System (Water Quality)
NRC	Nuclear Regulatory Commission
NSPS	New Source Performance Standards (Air Quality)
NURP	Nationwide Urban Runoff Program
OCS	Outer Continental Shelf
OCZM	Office of Coastal Zone Management
ODW	Office of Drinking Water
OPTS	Office of Pesticides and Toxic Substances

OSM	Office of Surface Mining
OWPO	Office of Water Program Operations
OWWM	Office of Water and Waste Management
POTW	Publicly Owned Treatment Works
PWS	Public Water Supply
R&D	Research and Development
RAMP	Rural Abandoned Mine Program
RASA	Regional Aquifer System Analysis Program
RCRA	Resource Conservation and Recovery Act; enacted as amendments to the Solid Waste Disposal Act
RCWP	Rural Clean Water Program
SCS	Soil Conservation Service
SDWA	Safe Drinking Water Act; enacted as amendments to the Public Health Service Act
SEA	State/EPA Agreement
SIA	Surface Impoundment Assessment (Drinking Water)
SIR	Survey, Investigation and Research Program
SMCRA	Surface Mining Control and Reclamation Act
SMSA	Standard Metropolitan Statistical Area
SSA	Sole Source Aquifer
STORET	National System to Store and Retrieve Water Quality Monitoring Data
TCE	Trichloroethylene
TSCA	Toxic Substances Control Act

UIC	Underground Injection Control
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USGS	U.S. Geological Service
WPRS	Water and Power Resource Service
WRC	Water Resources Council
WSRA	Wild and Scenic Rivers Act

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